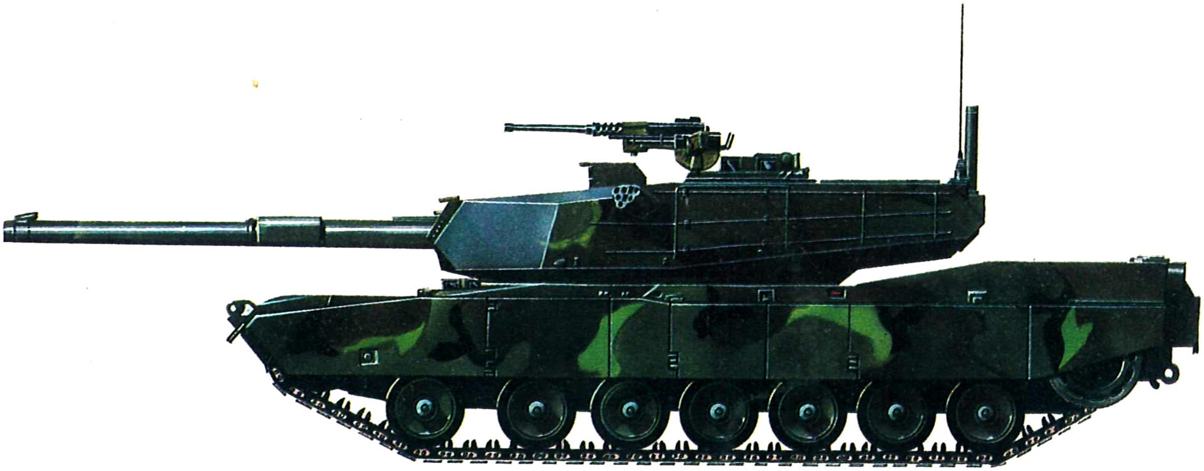
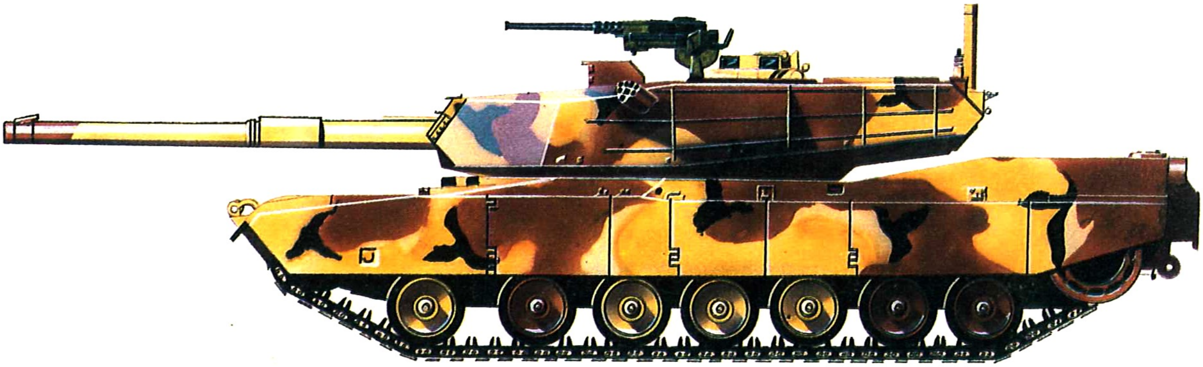
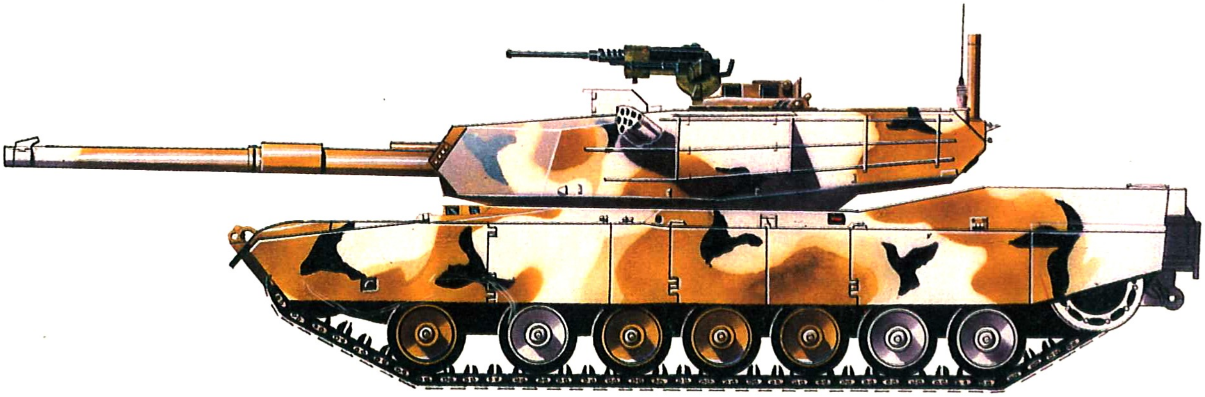
OSPREY · VANGUARD 41

THE M1 ABRAMS BATTLE TANK







Text and colour plates by **Steven J. Zaloga**

VANGUARD SERIES

EDITOR: MARTIN WINDROW

THE M 1
ABRAMS BATTLE TANK

Text and colour plates by

STEVEN J. ZALOGA

OSPREY PUBLISHING LONDON

Published in 1985 by
Osprey Publishing Ltd
Member company of the George Philip Group
12–14 Long Acre, London WC2E 9LP
© Copyright 1985 Osprey Publishing Ltd

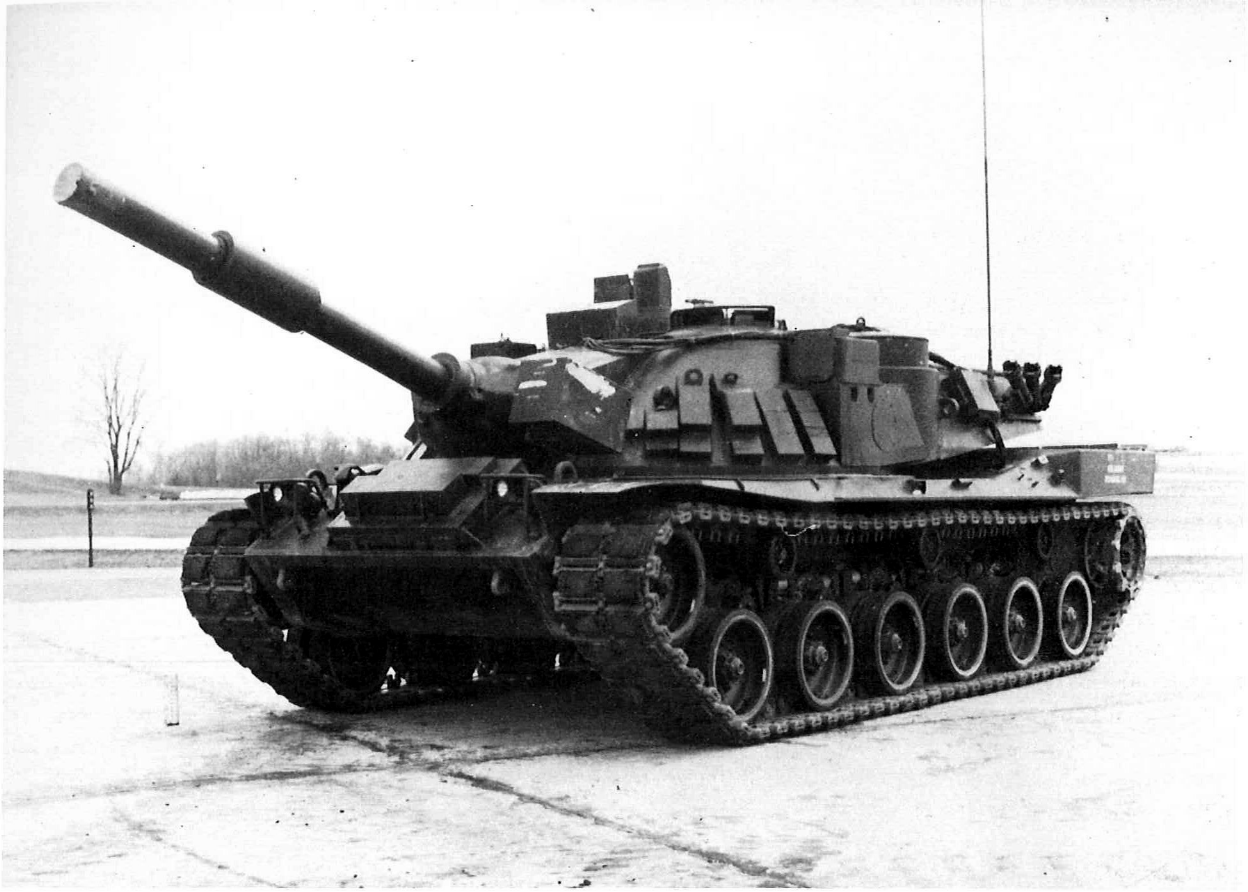
This book is copyrighted under the Berne Convention. All rights reserved. Apart from any fair dealing for the purpose of private study, research, criticism or review, as permitted under the Copyright Act, 1956, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without the prior permission of the copyright owner. Enquiries should be addressed to the Publishers.

British Library Cataloguing in Publication Data

Zaloga, Steven J.
The M1 Abrams. – (Vanguard series; 41)
1. M1 (Tank)
I. Title II. Series
623.74'752 UG446.5
ISBN 0-85045-584-7

Filmset in Great Britain
Printed in Hong Kong

Author's note:
The author would like to thank Maj. Tony Geishauser, Col. Bill Highlander, Maj. Scott Albro, Maj. Conley Thompson, and Lt. Colletti of US Army Public Affairs for their patience and help in the preparation of this book. Thanks as well to Jim Allingham and Hank Paulick of the US Army's Aberdeen Proving Grounds. A special word of thanks goes to Arnie Meisner, who provided photos and help with the plates relevant to the 1983 'Reforger' exercise. The author would also like to express his appreciation to Pierre Touzin, Lt.Col. James Loop (USA Retd.), and Mike Green for their generous help in providing other photos for this book.

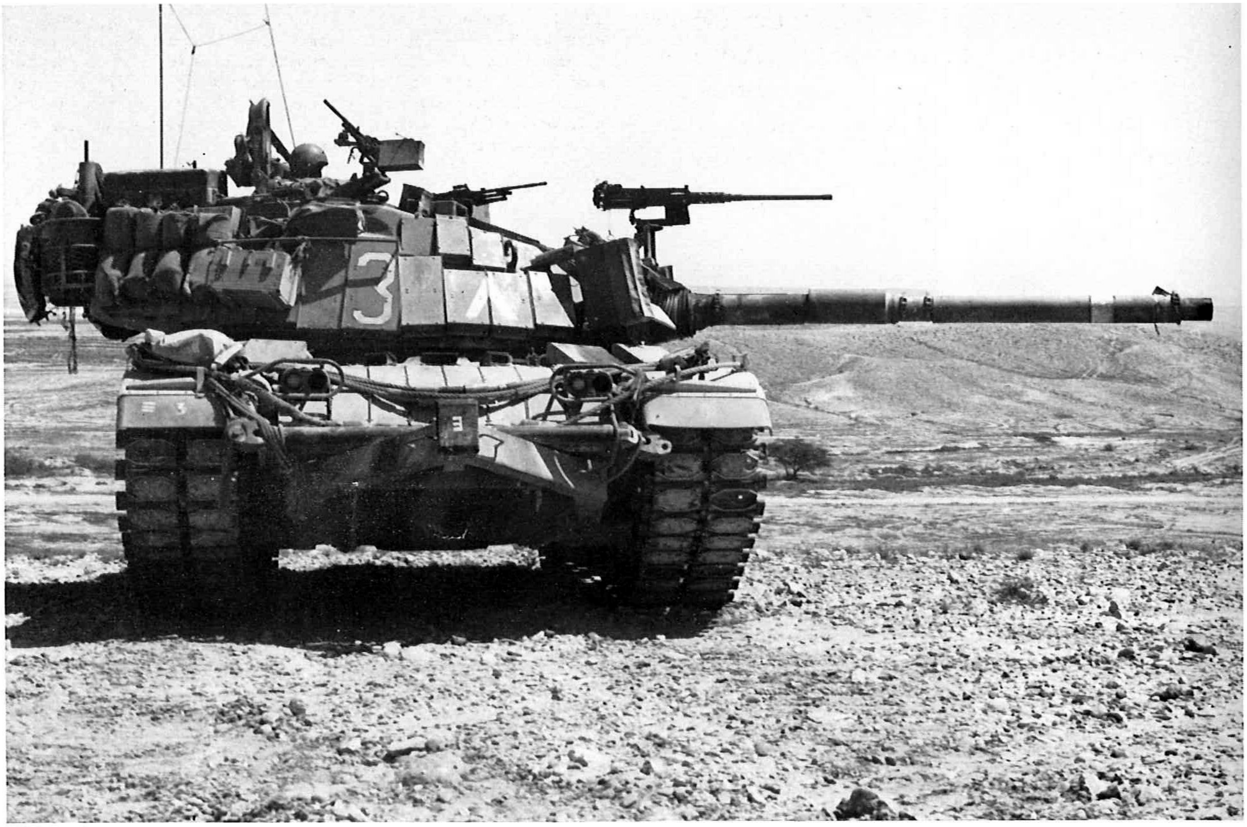


The ill-fated American–German MBT-70 programme ground to a halt in the late 1960s due to rising costs and technological problems in the design. This was excessively complex, and incorporated an automatic loader, hydropneumatic suspension, a guided missile/gun system, full CBR suite, a remote control AA gun, and a host of other systems which proved technologically immature. (US Army)

The Demise of the Tank?

Changes in weapons technology centrally affect the nature of modern warfare, favouring sometimes the defence, sometimes the attacker. The static trench warfare of World War I was fostered by the machine guns, breech-loading cannon and other weapons which favoured the defender. Tanks, as they matured technically and tactically, eventually swung the balance back in favour of the attacker, as was so evident in the mobile campaigns of World War II. The nature of the fighting in the 1973 Yom Kippur War, especially the battles between the Israeli and Egyptian armies in the Sinai, have led many observers in the Press to speculate that new defensive anti-tank technologies have undermined the viability of the tank on the modern battlefield. During the first week of fighting in the Sinai, the Israeli M60A1 tank battalions suffered grievous losses at the hands of Egyptian tank destroyer teams equipped with RPG-7 rocket launchers and man-portable 9M14M Malyutka (Sagger) guided anti-tank missiles. Some sources attributed over 50 per cent of Israeli tank losses to these types of weapons, though the Israelis have challenged these assertions. The popular Press suggested that tanks would soon go the way of the armoured knights after their disastrous encounter with the longbow at Crécy. These modern armoured behemoths, costing over a million pounds sterling, could be defeated by cheap, man-portable missiles and rockets. Or so it seemed to the Press.

Few observers were more interested in the outcome of the 1973 fighting than a team of US

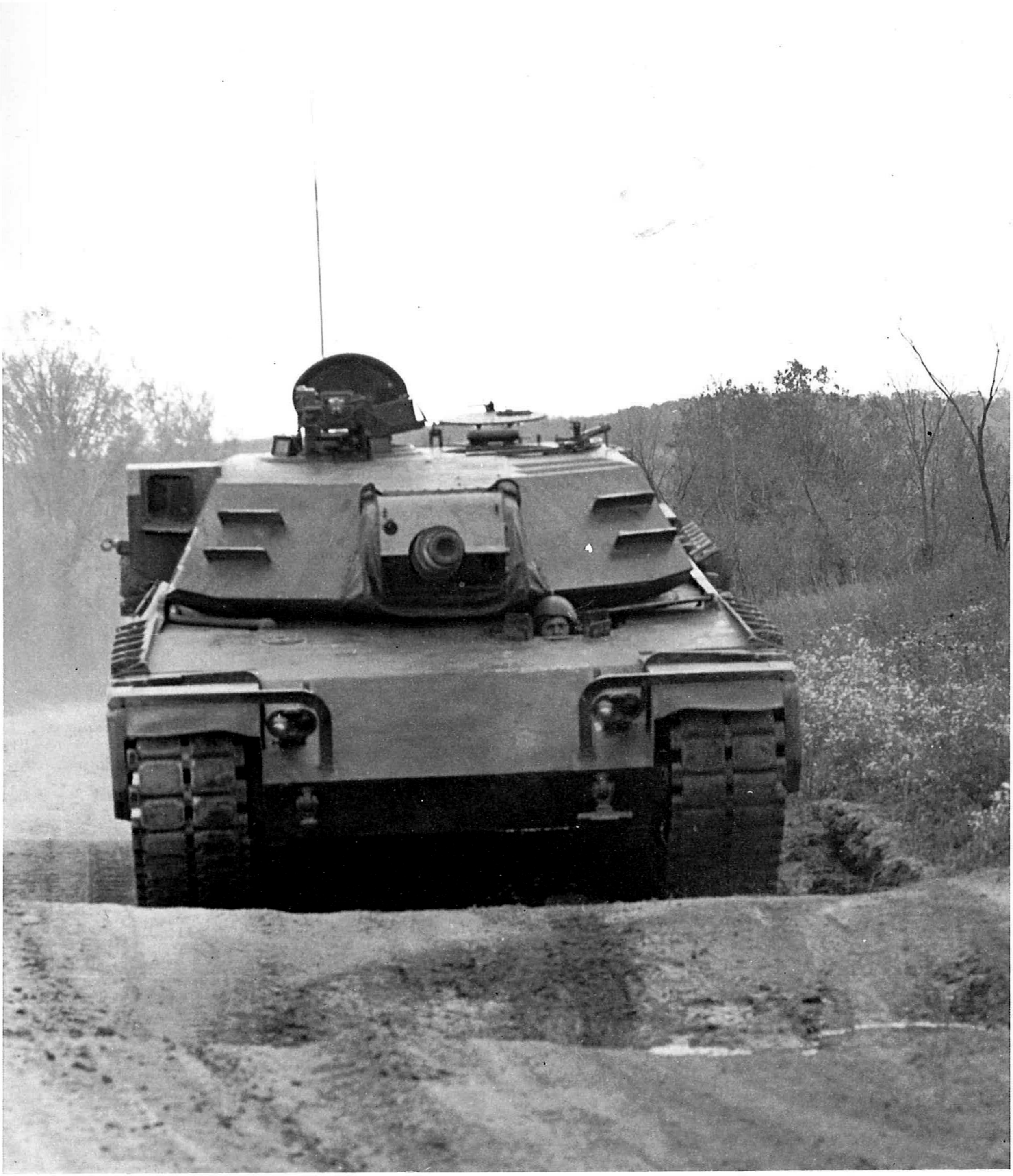


This Israeli M60A1 is fitted with the Blazer reactive armour system, which was first deployed in the 1982 invasion of Lebanon. This type of appliqué armour was developed mainly as a stop-gap solution to the threat posed by hand-launched anti-tank rockets like the RPG-7 in crowded urban battlegrounds. (Zahal)

Army tacticians, engineers and tank designers at a new programme office at US Army Tank and Automotive Command (TACOM) in Warren, Michigan. Congress had finally managed to kill the controversial and technically troubled MBT-70 tank. All that the Army salvaged out of the MBT-70 débâcle was Congressional assurance that the design of a new, more austere, tank would be funded at a modest level. So, in December 1971, work began on the third attempt to replace the venerable M48/M60 Patton series, and the new type was called XM1. Was this effort worthwhile if the tank was doomed by new guided missile technology?

US Army tank officers did not share the popular journalistic view of the significance of Israeli experiences in 1973. Army studies conducted in co-operation with the Israeli Army laid the blame for the heavy losses of tanks to anti-tank missiles more upon poor tactics in the first days of fighting than on any inherent shift in favour of defensive anti-tank warfare brought about by the use of missiles. Guided anti-tank missiles were hardly a novelty in 1973. They had first been used in 1945 by the Wehrmacht against the Soviet Army in the form of the early, wire-guided X-9 missile. Both the Israeli and Egyptian forces had employed wire-guided anti-tank missiles in the 1967 war, as had the Indian and Pakistani armies in the 1965 battles. In none of these encounters had they proved very effective. However, the US Army had employed its new TOW guided anti-tank missile with considerable success in the closing days of the US involvement in Vietnam; and the new Soviet 9M14M Malyutka served well not only in the 1973 Middle East War, but also in Vietnam. Guided anti-tank missiles were becoming a greater threat to the viability of the tank due both to their proliferation, and to technical improvements in their design which made them easier and more accurate to use.

Likewise, improvements in shaped-charge warhead designs were making the unguided anti-tank rocket weapons like the RPG-7 more threatening. Earlier rocket launchers such as the US LAW or the Soviet RPG-2 could penetrate the formidable armour of most modern battle tanks. However, after penetrating the armour they often had so little

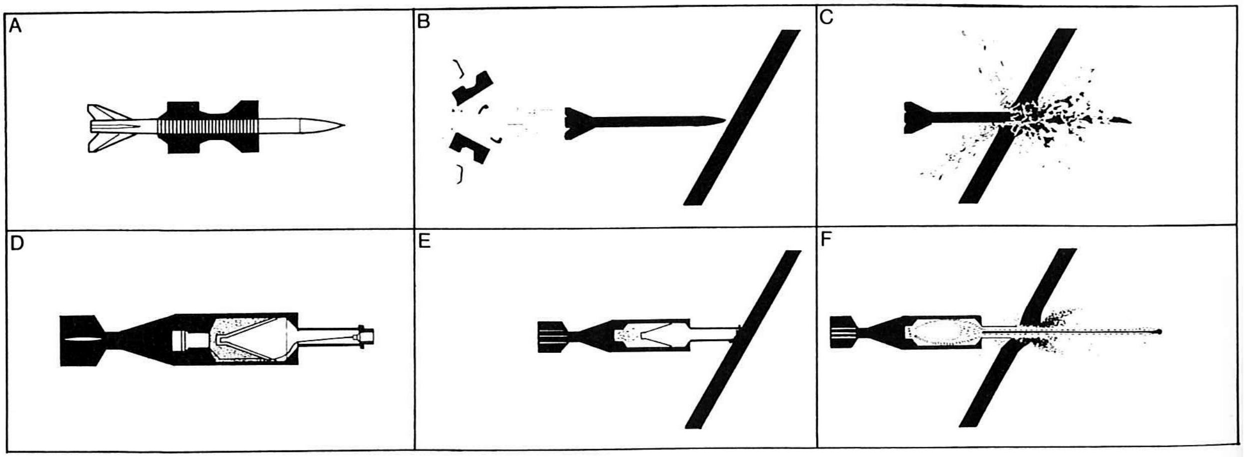

The prototype of the GM entry in the XM1 competition. In contrast to the Chrysler design, the GM version had a diesel engine. Note also that the thermal sight is located on the hull side rather than the roof. Chrysler's Defense Division was later sold to General Dynamics, who now run the M1 production facilities at Lima and Detroit as General Dynamics Land Systems Division. (GM)

A major requirement in the M1 design was high speed: a vehicle moving cross-country at high speed is difficult to hit, and a faster vehicle is also able to exploit battlefield situations better than a slower tank. This M1 at the Aberdeen Proving Grounds (APG) literally leaps over a small embankment while travelling at its top governed speed of about 45 mph. 'D-230' indicates the 230th production vehicle from the Detroit Tank Arsenal. (S. Zaloga)

explosive force left that no crippling damage was inflicted on the tank. The post-penetration effects of the RPG-7 were far more damaging, although even with this weapon, fewer than one out of eight tanks hit were put out of action.

Shaped charges and kinetic penetrators

Today there are basically two means of penetrating



Although the M1 is already in full-scale production, testing still continues at APG and other locations to ensure that the various technical 'fixes' selected during trials do work as planned. This mud-soaked vehicle has just gone through fording tests. (Michael Green)

tank armour: shaped-charge, chemical energy (HEAT: high explosive anti-tank) warheads, and kinetic energy penetrators. Kinetic energy penetrators like tank APDS (armour piercing, discarding sabot) and APFSDS (armour piercing, fin stabilised, discarding sabot) gun projectiles rely on the extreme velocity imparted to a very hard round by the tank gun to penetrate enemy armour. Kinetic energy penetrators require a considerable amount of propellant to fire them at the high speeds necessary to punch through armour. So far, it has not proved possible to design any sort of man-portable anti-tank rocket weapon which uses a kinetic penetrator. Instead, guided anti-tank missiles and unguided anti-tank rockets have relied on shaped-charge warheads to penetrate tank armour. Such warheads do not depend on the velocity of the round to penetrate the armour, and in fact have nearly equal penetration effects no matter what their velocity when they strike the armour. Rather, their penetrating effects come from the unique configuration of their warheads. The warhead has its explosive shaped around a hollow cone, with a fuze placed a few inches in front of the explosive to detonate it: the shaped explosive

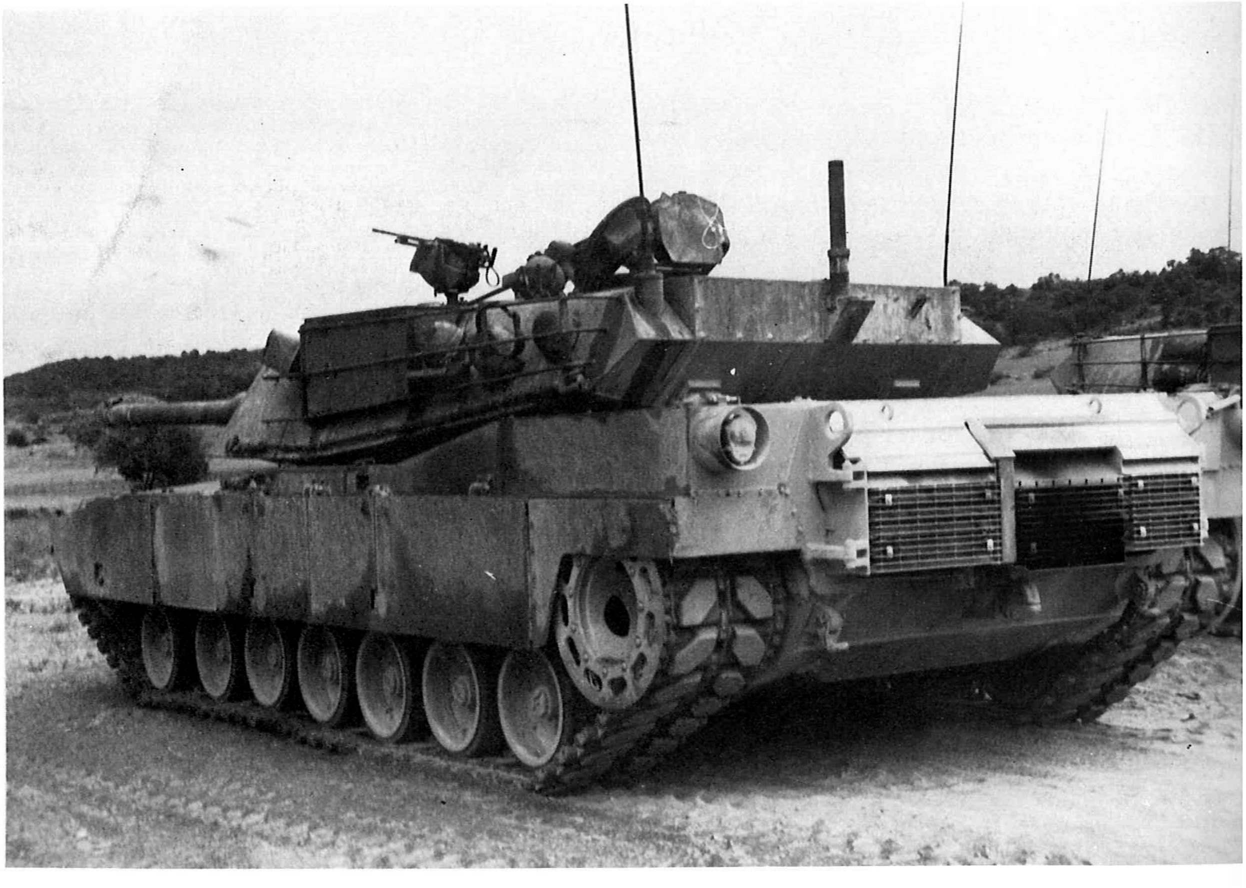
Opposite
(A) shows the configuration of an APFSDS kinetic energy penetrator round. The two basic parts are the sub-calibre finned penetrator, made of tungsten carbide or depleted uranium (stabaloy), and the sabot, which is made of lightweight material such as aluminium. (B) shows the sabot dropping away from the penetrator after leaving the barrel. (C) On impact with armour, the penetrator smashes through the armour by virtue of its high speed and mass, and sprays the inside of the enemy tank with a supersonic whirlwind of incandescent and molten metal shards. (D) shows the general configuration of shaped-charge, chemical energy HEAT rounds. At the tip of the round is a piezo-electric detector which triggers the fuze at the base of the explosive on impact with the target. The hollow stand-off probe configuration and conical shape of the explosive are very evident in this view. (E) On impact, the fuze is triggered and the explosive is detonated. (F) The explosive detonation is channelled into a very narrow tongue of fire which blasts and melts its way into the target. This drawing shows the explosion milliseconds after impact, as the HEAT round's blast has penetrated the armour and begun spewing metal off the inner walls of the target tank.

charge detonates milliseconds before coming in contact with the armour. Because of the shape of the charge, the explosion is channelled forward in the form of a fiery tongue of hypervelocity gas. This penetrates the armour through a combination of heat, which melts the armour, and hydropneumatic pressure which pushes the vaporised armour aside. A kinetic energy penetrator causes internal damage to a tank after penetration through the effects of the penetrator itself, which careens about the inside of the tank, smashing men and machinery. In contrast, a shaped-charge warhead causes damage by the effects of its fiery blast (if this has not been dissipated by penetrating the armour), by bits of armour debris scaled off from the site of the penetration, and by overpressure.

Cheap anti-tank rockets relying on shaped-charge warheads have been an increasing threat to tanks since 1942, when the first such weapons were deployed by the US and German armies. Since that time, tank designers have tried to cope with such weapons by innovations in armour design. In World War II two techniques were used. The German and Hungarian armies used thin sheets of armour placed about a foot from the main turret or hull armour. This stand-off armour detonated the rocket's warhead prematurely, and the effect of the shaped-charge warhead was largely dissipated in the space before it hit the actual tank armour. The US Army used sand-bags, which had a similar stand-off effect. Nevertheless, this technique was short-lived. New shaped-charge designs developed in the 1950s prevented the blast tongue from dissipating, and moreover, thin stand-off armour could actually *enhance* the damaging effects of the new, improved warheads.

Efforts to develop other armour innovations to defeat shaped-charge warheads began in the USSR

Field use has led to the adoption of a number of 'fixes'. This M1 of the 2nd Armd. Div. shows the cut-out rear skirts adopted by the division and other units to prevent mud from the drive sprocket becoming impacted. This rear view also shows some of the minor changes in configuration of the rear exhaust louvres in the intermediate production vehicles. The vertical post on the turret rear is the gun system wind sensor. (S. Zaloga)

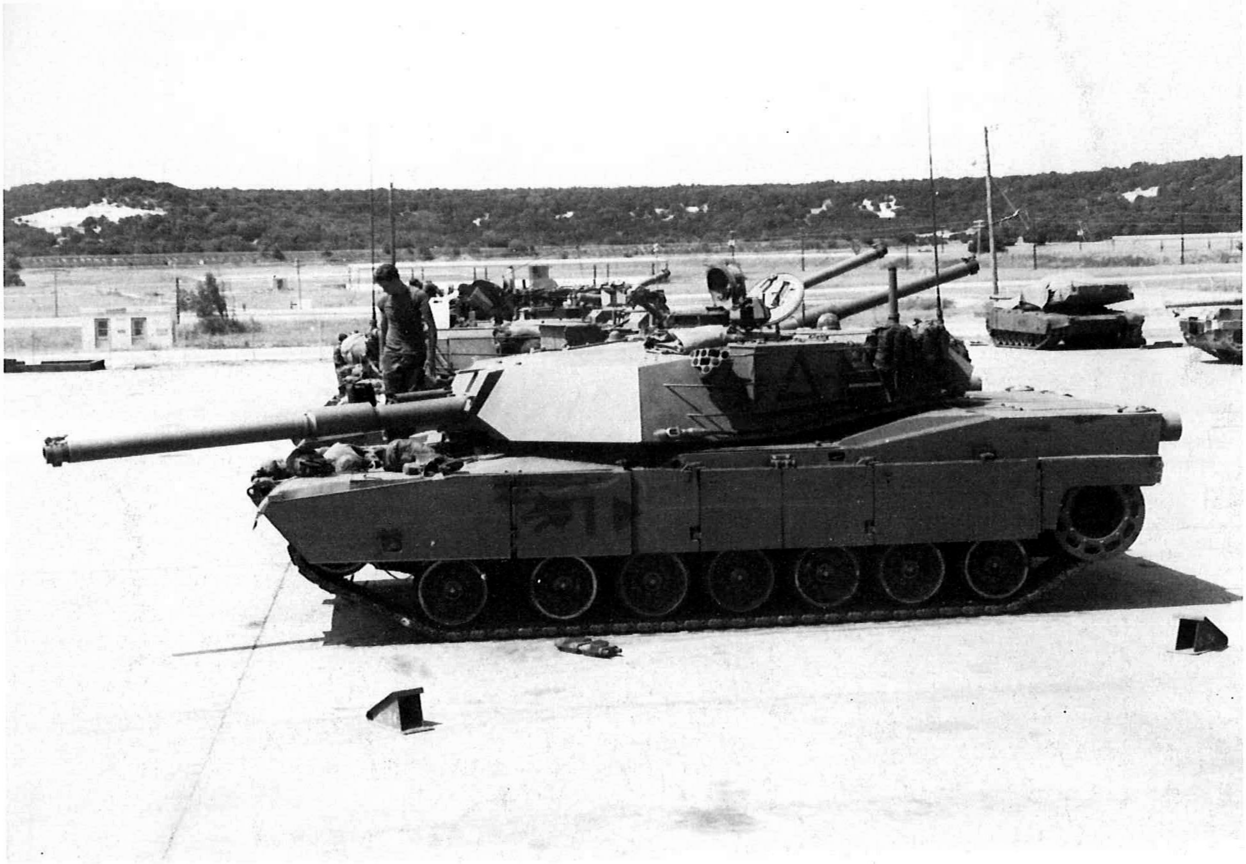


and the USA in the 1940s. The Soviets experimented with a special layered armour consisting of glass or ceramic plates interleaved with steel and rubber sheets over the main armour. Ceramic materials were attractive, since they are very hard and far more resistant to heat than steel armour. Their main drawback is that they are so hard that they are exceedingly brittle. When penetrated, they shatter and lose all protective value. In contrast, steel is more ductile, and when it is penetrated its integrity as armour is not uniformly lost, but only in the area of the penetration.

The US Army experimented with two techniques: silaceous core armour, and active armour. Silaceous core armour is essentially similar in concept to the Soviet layered armour, consisting of a panel of ceramic armour inside a number of layers of conventional steel armour. It was first experimentally fitted in the T95 tank project (which was the first attempt to replace the M48 family in the late 1950s). American tests showed that in terms of weight and cost, silaceous core armour was only effective when used in panels set at very shallow angles, e.g. on upper bow panels. When used on panels angled closer to the vertical plane, such as turret sides, it did not have enough additional protective effect to warrant its added cost. This greatly diminished its attractiveness, since shallowly angled plates, even of conventional steel armour, were in any case very difficult to penetrate with shaped-charge warheads, due to fuzing and other technical problems in directing the blast tongue. As a result, the US never adopted silaceous core armour on its tanks; though it would appear that the Soviet Army has adopted it to some extent in the bow armour of some late-model T-72 tanks.

The other technique examined in the USA, and probably in the USSR as well, was active armour. Active armour consists of explosive panels fitted outside the main body of conventional steel armour.

The first division to be completely re-equipped with the M1 was the 2nd Armored at Ft. Hood, Texas in 1982–83. This M1 belongs to 3/67 Armor, as is evident by its 'Hounds-of-Hell' insignia on the side skirts. (S. Zaloga)

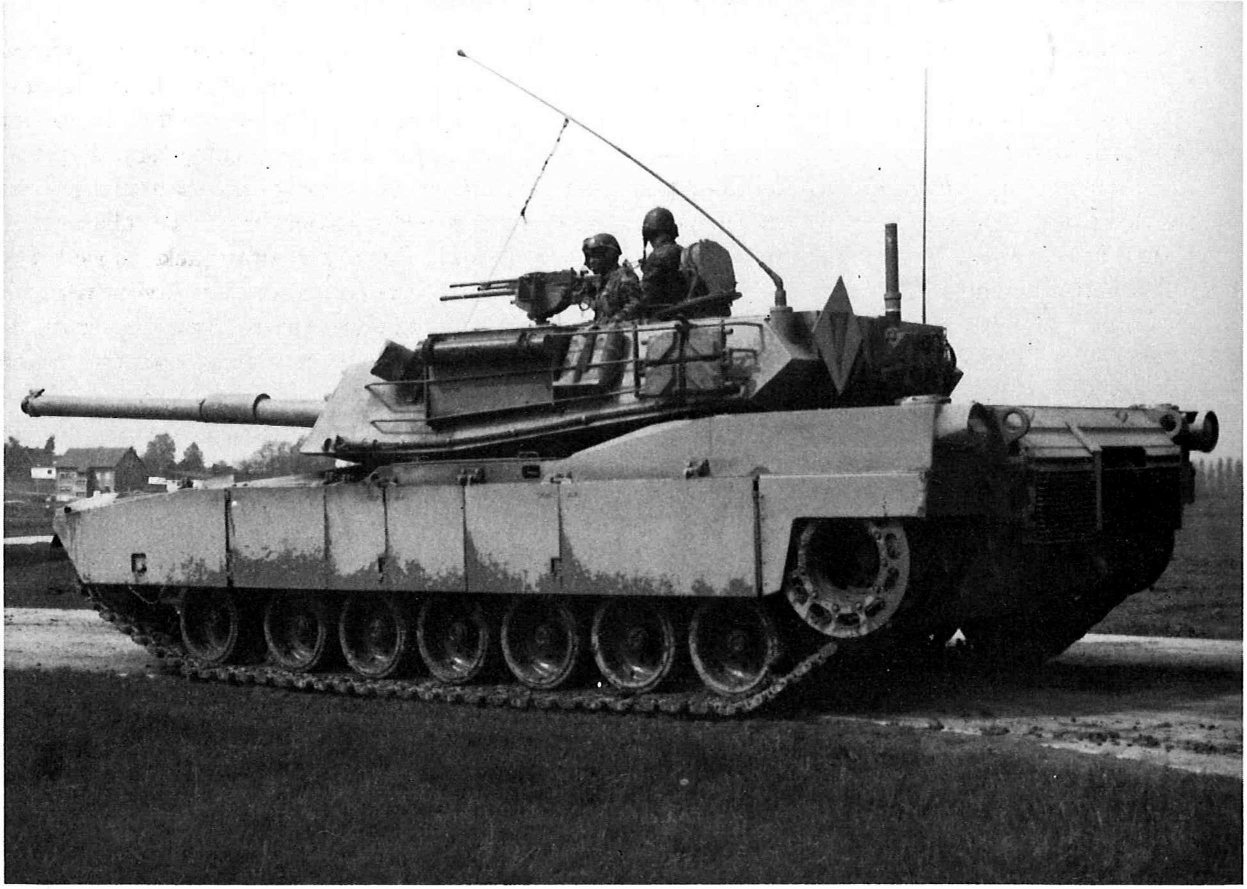


There was a conceptual US design to trigger the explosive armour by means of a radar or other sensor which would detect an incoming round. This system was hopelessly complicated and was abandoned before serious work was initiated. A simpler idea was to use panels of explosive which would be detonated on contact by an incoming shaped-charge warhead. The aim in this case was to disperse the blast tongue before it could properly form and penetrate the main steel armour. There are considerable technical difficulties in such a system. Finding an explosive that is only detonated by shaped-charge warheads, and not by every stray machine gun bullet, has proved to be a nearly insurmountable problem. Moreover, even should the system work as planned, such armour poses a real hazard to crewmen who may have their heads exposed when the active armour is detonated, and to nearby friendly infantry. The Israeli Army deployed an active armour system known as Blazer on its M60A1 and Centurion tanks in the 1982 invasion of Lebanon. The system was not without its shortcomings, but was felt useful in spite of the problems due to the threat from RPG-7s in the confined urban areas of Lebanon.

Chobham armour

In the 1960s the MVEE at Chobham, England made a key breakthrough in the development of an armour resistant to shaped-charge warheads. Although details of this type of armour, called Chobham armour, are still tightly classified, articles in the US and Soviet press make it possible for the first time to provide a speculative assessment.

Chobham armour would appear to be a derivative of silaceous core armour, but in a much more sophisticated form. The main problem with

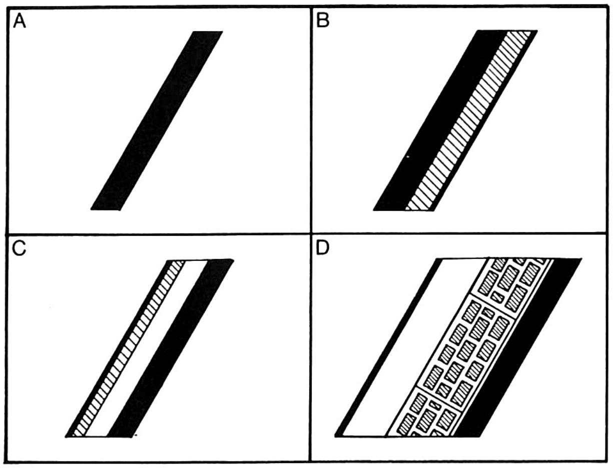


The first unit in Europe to receive the M1 was the 64th Armd. Regt. of the 3rd (Mech.) Inf. Div. in Germany. This is a vehicle of D Co., 1/64 Armor, as is evident from the unit plate on the turret rear. (Michael Green)

silaceous core armour is its brittleness. The brittleness of the ceramic material is not such a problem when it is struck by shaped-charge warheads, but rather when struck by kinetic energy penetrators. When hit by such a penetrator it tends to shatter, and its protective integrity is lost over a large area, not confined to the strike area alone. Since tank armour must protect against both shaped charges and kinetic energy penetrators, this has tended to rule out ceramic core armour.

The MVEE innovation was to recognise that the ceramic core armour need not be configured in large plates. If it is configured in hundreds of small plates, somewhat like the iron scale armour of ancient warriors, the impact of a kinetic energy penetrator might destroy a small segment of the inner layer of ceramic armour, but would not lead to the loss of the whole area. The small ceramic plates are made of a material somewhat akin to that used on the ablative shield of the US Space Shuttle. These ceramic tiles are hard enough to withstand considerable pressures, and are far more resistant to extreme temperatures than conventional steel armours. The ceramic scale plates are locked in a matrix of aluminium, plastics and glues, and are probably bonded with some form of fabric armour like Kevlar to provide further resistance to deformation. Defence against kinetic energy penetrators is provided by conventional steel armour, as well as the layering effect of the Chobham armour, which can help to break up certain types of kinetic energy penetrators and reduce their impact.

In the late 1960s the British Army agreed to turn over the results of its Chobham armour research to the US and German armies. The new armour was not incorporated into the MBT-70 which was completing its development at the time, since it had certain peculiarities which would have made it necessary to completely redesign the armour configuration of the MBT-70. Nevertheless, in 1971 when work began on the XM1 design, a major requirement was the incorporation of Chobham armour in the new tank. The Israeli experiences in the 1973 war provided added impetus for the design of a new tank to replace the M60A1.



Contemporary armour configurations. (A) shows conventional homogenous steel armour as used in tanks since 1914. (B) shows the early silaceous core armour of the 1960s, with an initial layer of steel followed by a ceramic panel and a thin steel backing. (C) shows reactive armour consisting of an initial thin layer of steel to detonate the HEAT round, a layer of reactive plastic explosive, spacing, and finally the main layer of conventional steel armour. (D) is a speculative depiction of Chobham armour: an outer steel layer, open spacing, a matrix containing ceramic bar armour, and a final layer of steel.

The M60A1, which made up the bulk of the US Army's fleet as well as the bulk of the Israeli tank forces in the Sinai fighting, was an exhausted design. It was a lineal descendant of the M26 Pershing tank of 1944 which had been updated continuously over a 20-year period. Its engine, transmission and suspension were all evolutionary outgrowths of the same 1943 technology. This had the advantage of keeping manufacturing costs down, and added considerably to the reliability of the basic tank. But it had drawbacks as well. For example, its outdated powerplant layout made it very difficult and time-consuming to repair in the field as compared to its contemporaries such as the German Leopard I.

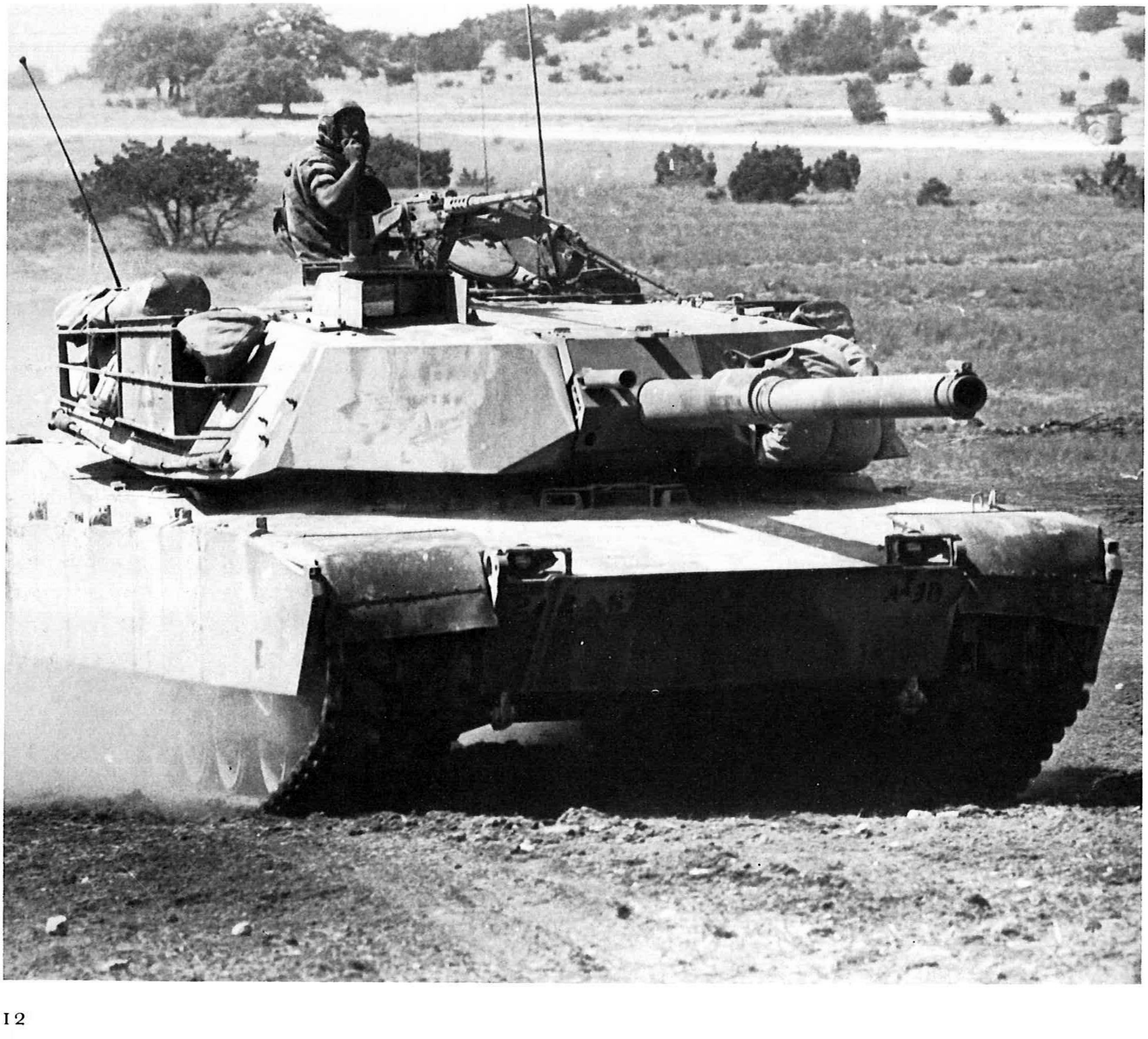
Moreover, the 1973 war had uncovered certain alarming problems in the M60A1's armour layout. There were weaknesses in the forward armour chins and at the base of the turret ring. Furthermore, when the turret was penetrated, the lines feeding the hydraulic turret traverse system were sometimes ruptured, spraying the inside of the turret with a highly volatile mist of 'cherry juice' which exploded and burned the crew. The positioning of much of the ammunition in the rear turret bustle also exacerbated the problem of catastrophic internal vehicle fires fuelled by shattered ammunition propellant cases. The high commander's cupola was also thoroughly despised by Israeli tank commanders. Its M85 machine gun was very unreliable and difficult to feed. Moreover, due to its height and location, the cupola had a high probability of being hit by enemy tank shells, and when this occurred the whole one-ton cupola was often sheered off – and along with it, the upper torso of the commander.

Some of these problems could be corrected by the addition of appliqué armour and the substitution of a less volatile hydraulic fluid. However, some of the flaws were inherent in the M60's basic design, and required development of a whole new design.

An M1 of 2/67 Armor, 2nd Armd. Div. at Ft. Hood in 1983. The sights for the gunner and commander, in the box in front of the tank commander, have small armoured doors which can be closed to protect the sights when they are not in use. (US Army)

The XM1 Requirements

The XM1 tank design team did not agree with the popular Press perception that the 1973 Middle East war signalled the demise of the tank. The availability of the British Chobham armour offered the hope of completely undercutting the effectiveness of anti-tank weapons relying on shaped-charge warheads. This was no minor consideration. Take, for example, the weaponry of a Soviet motor rifle division (MRD). An MRD of the period fielded a total of 935 anti-tank weapons including tank guns, RPG-7s, guns and missiles on the BMP-1, and so on. Of these 935 weapons and launchers, fully 700 relied *exclusively* on shaped-charge warheads for

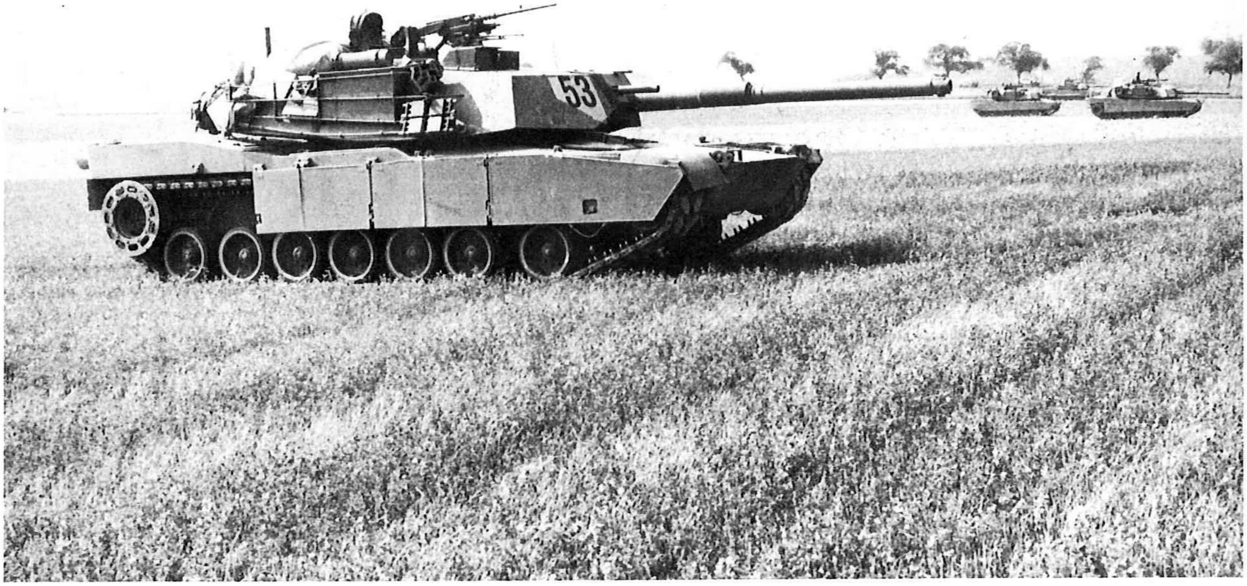


An M1 of the 2nd Armd. Div. on night tactical exercises in 1983. (2nd AD Public Affairs)

their anti-tank effect. This leaves about 220 tank guns and 18 T-12 anti-tank guns capable of firing kinetic energy penetrators. However, only about 30 per cent of the ammunition carried aboard Soviet tanks is of the kinetic penetrator type, the remainder being high explosive and shaped-charge rounds. In short, the adoption of composite Chobham armour could render a considerable portion of the anti-tank weaponry of a typical Soviet unit nearly useless in head-to-head combat.

Protection, then, was a prime requirement of the new design. Related to this was the decision to incorporate a fire suppression system to reduce the risk of crew injuries if armour penetrations did occur. Ammunition was to be stored in special compartments which would channel the blast away from the crew if the ammunition was set afire. Finally, the new design was to stress mobility. A fast-moving, agile tank is far more difficult to hit than a slow-moving or stationary tank. The XM1 was designed to have full fire-on-the-move capability, unlike the M60A1, which had to stop to fire accurately. It was designed with twice the horsepower of the M60 in order to traverse terrain at much higher speeds. New suspension designs and rotary shock absorbers were to give a more stable ride.

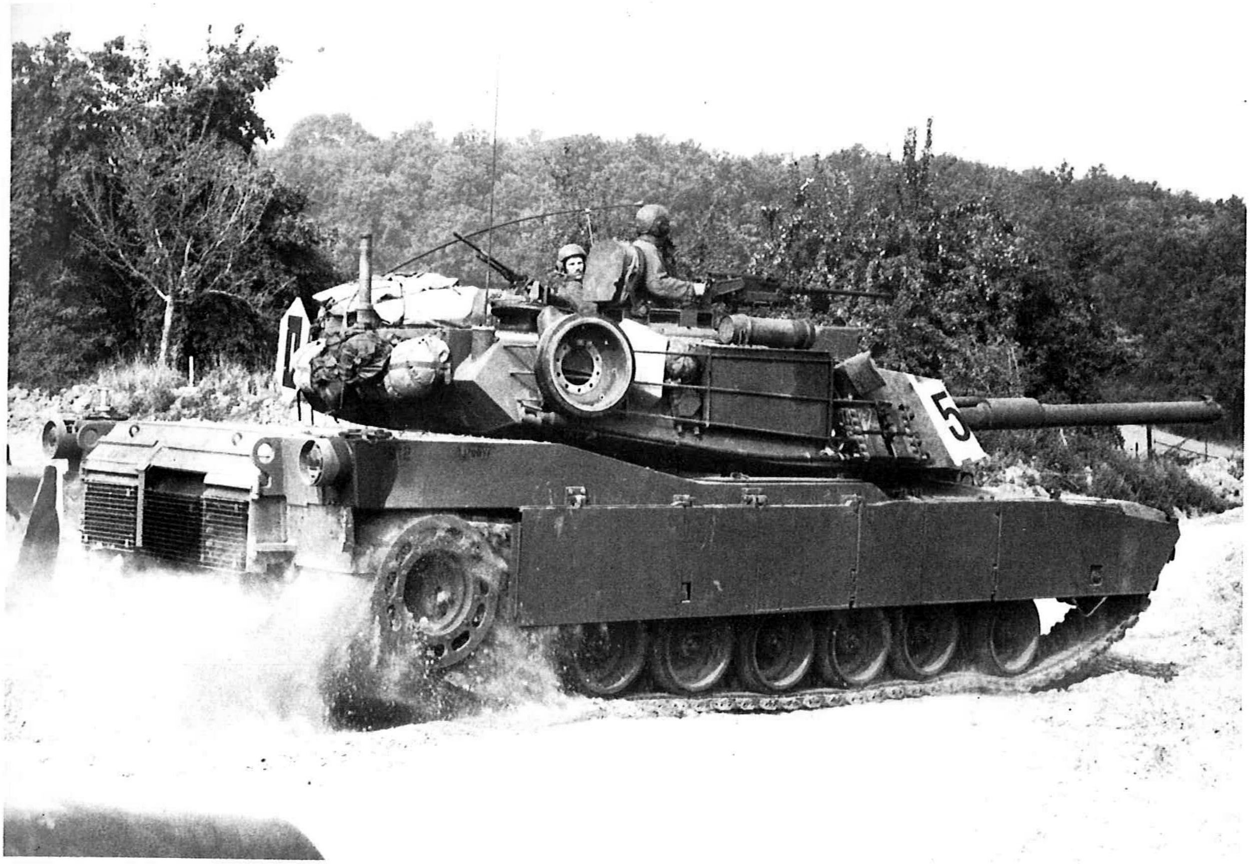
One of the more surprising results of the early XM1 test programme concerned the selection of the main gun for the tank. To begin with, unconventional designs like the Shillelagh gun/missile launcher tried on the M551 Sheridan and MBT-70 were ruled out in view of their disastrous effects on previous programmes. The demise of these weapons was brought about not only because of their troubled development history, but also because of



A company of M1s of 64th Armor spread out in battle formation during the 1982 'Reforger' exercises. The successful employment of the M1 in this exercise was the first clear vindication of the Army's decision to stick with the M1 despite exaggerated Press criticism. (Pierre Touzin)

important breakthroughs in ammunition technology. In the late 1960s the first practical APFSDS were produced. These kinetic energy penetrators used small, dart-shaped penetrators made out of tungsten carbide. They proved to be far more accurate than the earlier APDS kinetic energy rounds, and their penetration was superior to the APDS as well. The advent of the APFSDS round signalled the beginning of the end of NATO reliance on HEAT shaped-charge anti-tank rounds for tank combat. The appearance of the APFSDS also co-incided with the development of efficient and reliable laser rangefinders. The two technologies were synergistic, and offered the high accuracy at long ranges previously possible only with expensive and complicated missile systems – and at a far lower cost. For this reason the Army decided to stick with the existing M68 105 mm gun, a licensed copy of the British L7 gun. The new M735 APFSDS round, with a tungsten carbide arrow penetrator, was capable of dealing with any existing Soviet tank, and successes in developing machining techniques to permit the use of depleted uranium metal in penetrators offered good growth potential for the future to deal with newer Soviet tank types. The depleted uranium (DU) penetrator offered better armour penetration and post-penetration destruction than the tungsten carbide penetrators due to the pyrophoric effects of uranium on contact with steel armour. On impact it slices through the armour, shattering in the process, and spewing out a stream of hypervelocity, incandescent metal shards into the interior of the target tank.

With basic requirements in mind, the US Army awarded two competitive development contracts to Chrysler and General Motors in the summer of 1973 to begin design of actual prototypes. One reason for the unusual decision to develop the new design competitively was the desire on the part of the Department of Defense to examine a diesel vs. a gas turbine powerplant. The GM prototypes were



The 64th Armor initially removed the rearmost skirt to solve the mud impacting problem, but in 1983 adopted the 2nd Armd. Div.'s solution of a cut-out rear skirt. This M1 taking part in the 1982 'Reforger' exercise is covered with the usual layer of personal stowage. (Pierre Touzin)

to be fitted with a new diesel engine, while the Chrysler prototypes were to be fitted with a novel turbine engine. The XM1 was the first tank design in which full turbine power was seriously considered. Interest in the use of a turbine was due mainly to the fact that the Army had had very favourable results in its helicopter fleet when it changed from more conventional engines to the newer turbines. The turbine's main advantage is that it is smaller, lighter-weight, and requires less maintenance than diesels. Or at least, such was the Army's hope.

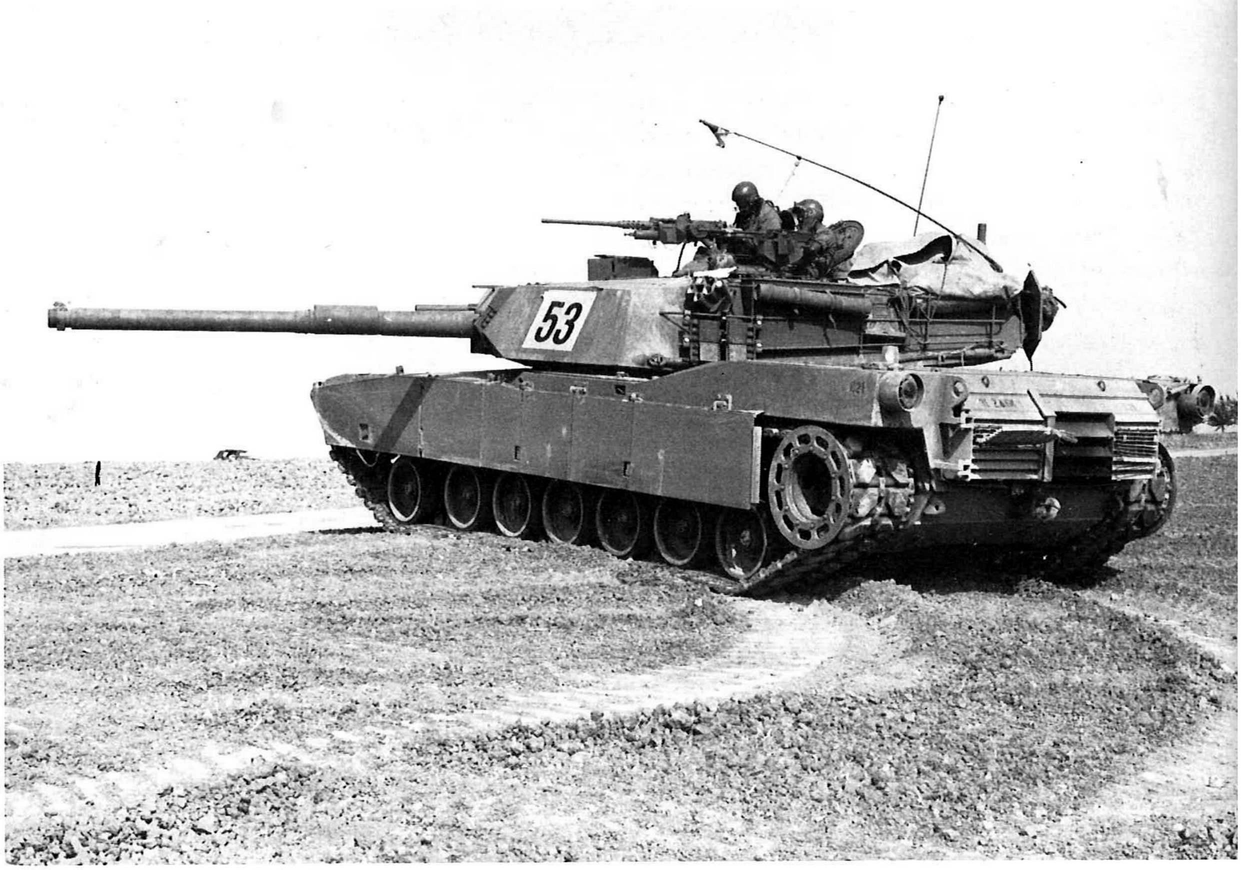
The NATO standardisation question

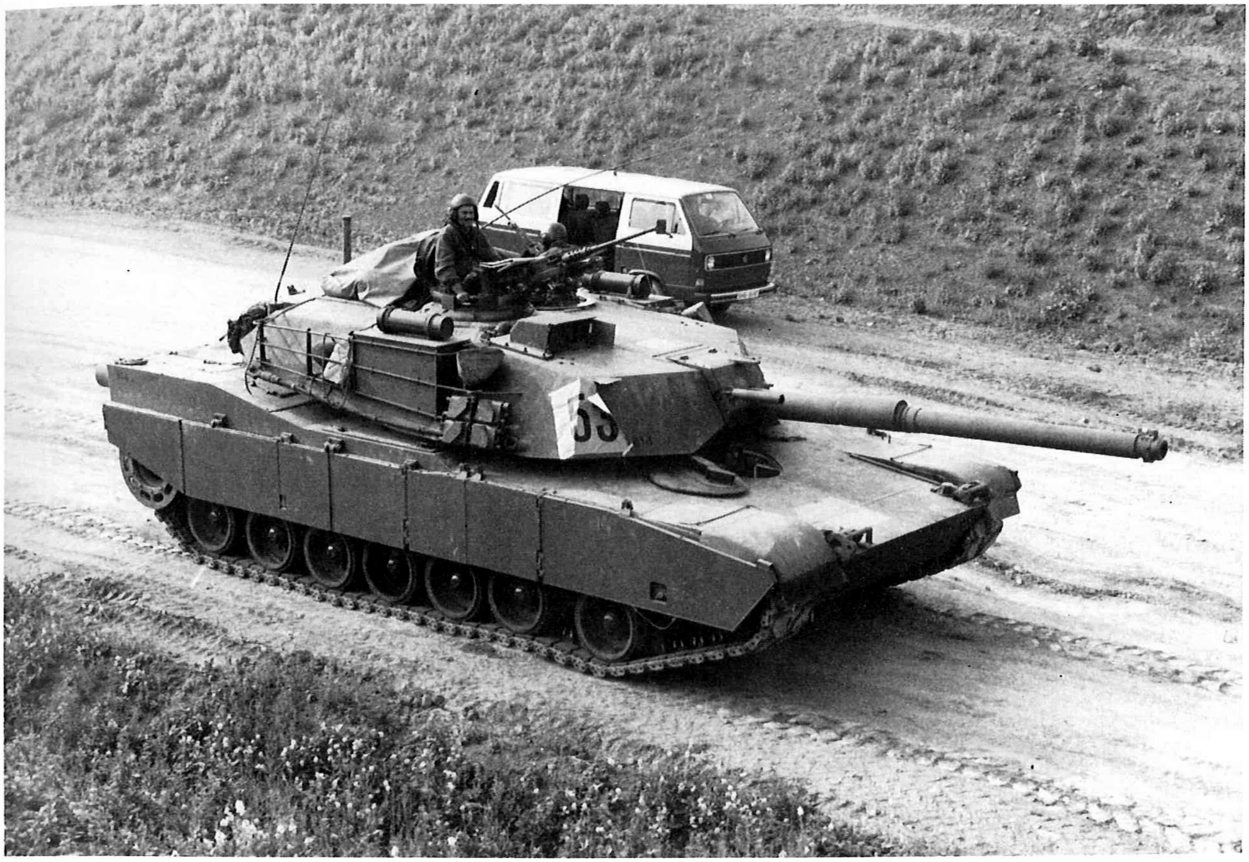
Late in 1973 the competition became somewhat muddied after Secretary of Defense Schlesinger agreed to German requests to enter a modified version of their new Leopard II as a contender in the programme. The US Department of Defense (DoD) was promoting co-operative NATO development efforts at the time, and to have rejected the proposals would have reinforced European perceptions that the US preferred US-dominated 'co-operation programmes'. The US Army was not wildly enthusiastic about the decision, as it had already examined a Leopard II chassis and had found it wanting. In 1974 the US signed an agreement with the German government promising to make 'all reasonable efforts to achieve maximum standardisation'.

Nevertheless, the two American vehicles were developed on the basis of the original schedule, and initial prototypes were delivered to Aberdeen Proving Grounds (APG) early in 1976. The initial plans called for selection of a winner in July 1976, but the Germans asked that testing be delayed seven months until the arrival of the Leopard II AV (American Version). The German entry had been delayed due to the need to considerably redesign the armour configuration. The Leopard II had originally been designed to the same protection standards as the earlier MBT-70 programme, not to the far more stringent requirements of the XM1. The first of the Leopard prototypes arrived in September 1976; and the following month, the US Army announced that it had selected the Chrysler prototype from amongst the American contenders for full scale engineering development. The Germans were dismayed by this decision, fearing that it pre-ordained the selection of the Chrysler vehicle as the final winner of the programme. The Army contended that it was still willing to consider the Leopard II. Later Army tests found both tanks to be equally acceptable in most areas, except that the armour configuration of the XM1 was superior. Furthermore, estimates indicated that the Leopard II would cost more to manufacture than the XM1.

In January 1977 the US and German representatives announced the decision to withdraw the Leopard II from the planned side-by-side tests with the XM1. The reasons for this decision have never been made entirely clear. The US licensee for the Leopard II, FMC Corp., was unwilling to invest its own funds in preparing a production proposal on the Leopard II, as its management felt that the chances for the selection of the Leopard II were slim. The US Army had placed protection as its primary requirement, and it was in this one area that the US tests had found the Leopard II most deficient. There was also the accusation that the US Army would not seriously consider the possibility of having as prestigious a weapon system as its main battle tank based on a foreign design. However, the US Army retorted that it had expressed its willingness to accept the Leopard II if it proved superior in tests, while the Germans were unwilling to make the same commitment in regard to the XM1. The heart of the problem was that the two countries had different requirements for their next

The large blue panel with black '53' identifies this M1 as a tank of 64th Armor during its participation in the 1982 'Reforger' exercise. The tubular container on the turret side is an empty shell packing tube. These are popularly used by US tankers to store personal items on the outside of the tank with a certain measure of protection against rain and dust. (Pierre Touzin)





The massive size of the turret on the M1 is clearly evident in this view of a tank of 64th Armor. Nevertheless, the M1 is significantly lower than the M60A3 which preceded it. (Pierre Touzin)

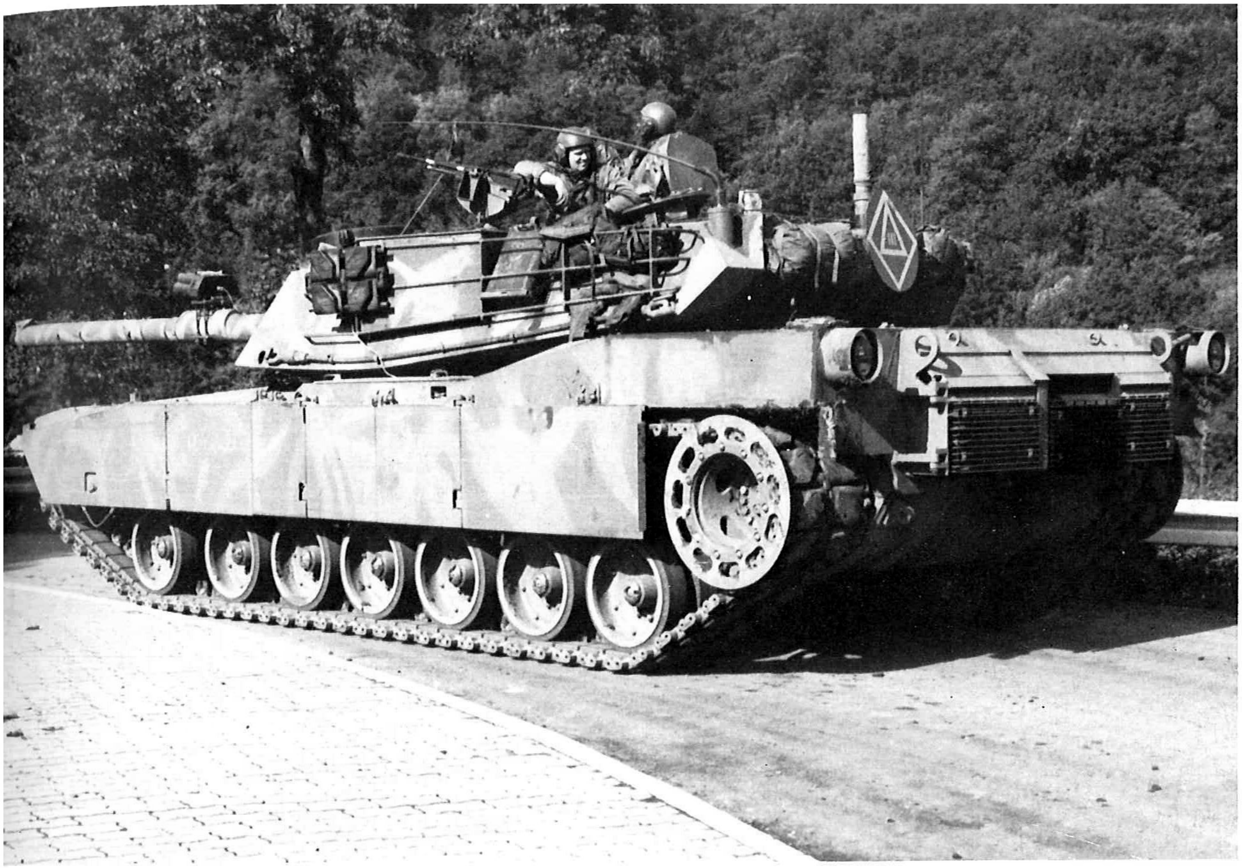
main battle tanks, and neither was anxious to throw away years of work on designs which embodied their own requirements.

In May 1977 Germany and the US agreed to press for standardisation of components between the two tanks. The systems in question were the track, main gun and powerplant. The US made a commitment to adopt the German 120 mm gun after a series of trials between various British, American and German guns and ammunition types which had begun in 1975. Although tests of the British guns (including a new 110 mm gun and the Chieftain's 120 mm gun) had been favourable, there was little likelihood of adopting either of these weapons since the British tank fleet is so much smaller than that of Germany. Standardisation was a major criterion due to the close results of the trials between the various weapons. The US Army resisted any efforts to immediately incorporate the 120 mm gun on the M1, and opted instead to fit the 105 mm gun on about the first half of the production run. There were a variety of reasons for this decision. To begin with, there was the general consensus that the newer 105 mm ammunition types were more than adequate to deal with Soviet tanks, and that newer types of ammunition would keep pace with Soviet armour developments. The adoption of the 120 mm gun would inevitably mean that the XM1 could carry fewer rounds, and there was considerable concern that the German ammunition for the gun was not yet sufficiently mature. The 120 mm ammunition used a self-consuming case (except for a small primer stub case at the end); and in view of the disastrous US experiences with self-consuming cases on the M551 and MBT-70, there was no chance that the US Army would countenance any delays in its tank production programme due to ammunition problems such as had occurred with the M60A2 and M551 Sheridan in the late 1960s. Instead, the Chrysler prototype had the forward turret rede-

The eternal chore of tankers is tank maintenance. Unlike the family car, a tank requires several hours of work by the crew each day to check oil and lubricant levels, filters, track tension, and a host of other things. This is an M1 of 11 ACAV during the initial phases of 'Reforger' 1983, before the mud camouflage was applied. (Arnold Meisner)

signed with a new universal trunnion which would allow the 120 mm gun to be fitted later in the production run without major redesign. Other aspects of the co-operation agreement fell through. In 1980 the Germans rejected the possibility of adopting the XM1's transmission or AGT-1500 turbine for use in the Leopard II. The US Army also rejected the German track, feeling that it added too much weight to the XM1, and fearing that it might be linked to vibration and noise problems which were plaguing the Leopard II at the time.

Beginning in February of 1978, the first of 11 final development prototypes of the XM1 were delivered for trials before the production go-ahead was authorised. In an unusual step, both operational and developmental testing were conducted concurrently to cut down development time. Developmental testing is concerned with examining the design from a technical and engineering standpoint, and with working out the mechanical 'bugs'. Operational testing consists of trials by Army units to determine whether the tanks are satisfactory in a tactical setting. The trials revealed a host of problems, mainly in the power train. The turbine engine proved far less reliable than the initial optimistic forecasts, and did not attain its required goals. Many of the engine problems were traced back to excessive dust ingestion. The tracks did not live up to the over-optimistic requirements, and they had a tendency to shed. These dim results caused some consternation in Congress, but part of the problem lay in the concurrency of the tests themselves. Under the usual schedule, the developmental trials would uncover technical problems and resolve them before the operational trials were undertaken. But because the trials were conducted concurrently, problems uncovered in the development trials also manifested themselves in the operational trials, which tended to exaggerate their seriousness. A special panel was convened to



An M1 of 1/11 ACAV during 'Reforger '83'. The mud camouflage, applied to confuse opponents into thinking the M1s were German, varied from tank to tank. (Pierre Touzin)

examine the power train problems, and besides outlining various problems to be resolved, concurred with the Army's decision to press ahead with the controversial turbine engine rather than developing and substituting the GM prototype's diesel engine.

Ill-founded media hostility

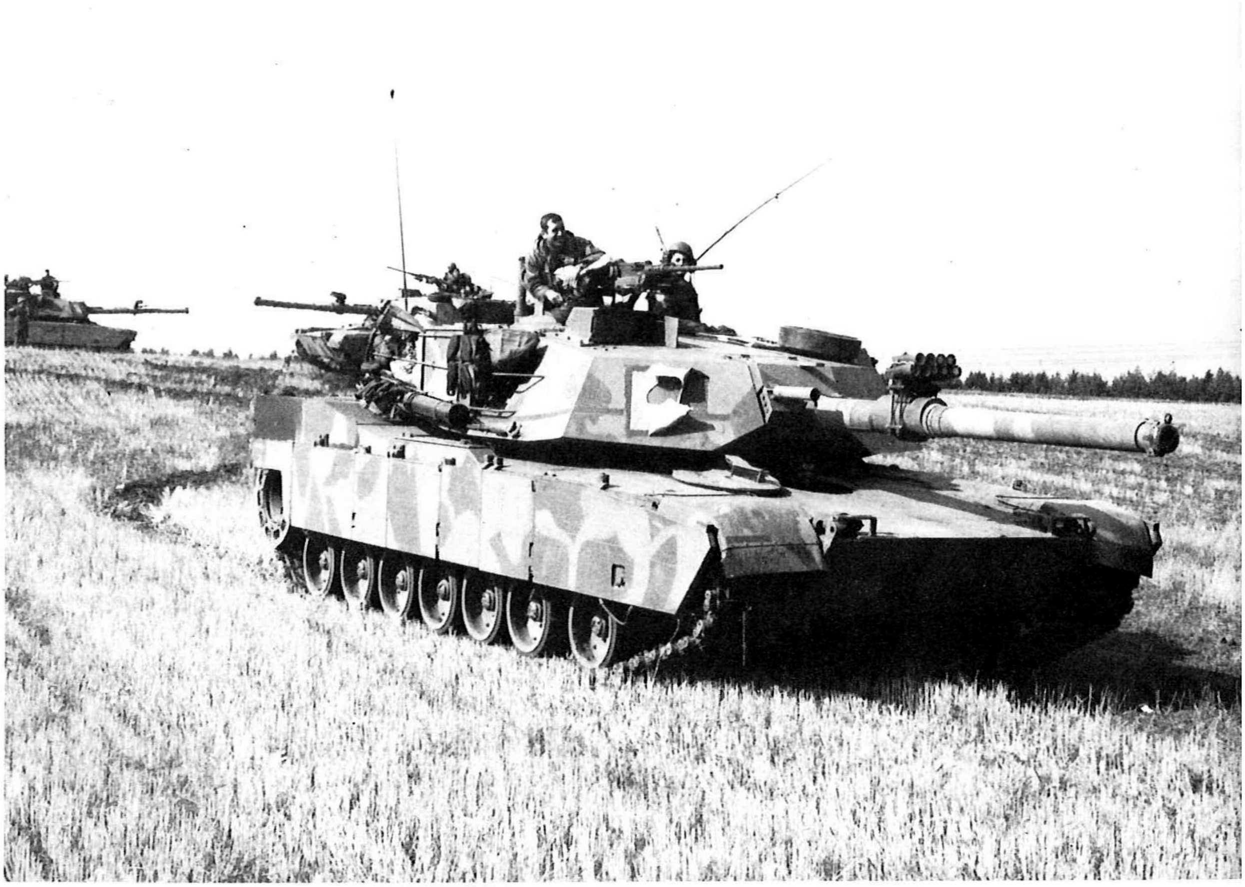
The development troubles soon attracted national Press attention. The American media, more influential as a government watchdog after the Watergate affair, took up the crusade to expose governmental malfeasance with considerable zeal. The XM1 was lambasted as a classic case of the Pentagon's gold-plating of weapon systems; it was depicted as a death-trap and a million-dollar dud. The lynching of the XM1 in the newspapers and on TV was based upon ignorance of the central issues in the programme. Lacking any engineering background or any familiarity with the normal course of tank development programmes, the Press failed to appreciate that the whole point of the trials was to uncover technical shortcomings in the XM1 design before the tank entered production. Its designers never expected the XM1 to pass through the trials without displaying flaws; no prototype tank ever does. Moreover, the flaws uncovered in the XM1 trials were not particularly serious compared to other recent tank programmes such as the Chieftain, MBT-70, or even its most immediate contemporary, the Leopard II.

Some of the Press criticism was far less substantial than the concerns expressed over XM1 engine reliability; and some was frankly silly. One ABC-TV programme, in all seriousness, questioned the XM1 programme on the basis of a belief that the XM1 could be readily knocked out by an RPG-7 rocket. This ignored the whole rationale of the programme, with its incorporation of Chobham armour and other passive protection systems. The Project on Military Procurement, a private lobby group which played a major rôle in whipping up

Press criticism of the XM1, attacked the design over its allegedly irresponsible use of a hydraulic turret traverse system; and questioned whether so much attention should be paid to the tank gun system, since their reading of George Patton's writings had led them to believe that the machine gun was the most useful weapon a tank possessed! The PMP criticisms also failed to appreciate the significantly reduced fire risk in the XM1 due to the armour, fire suppression system, compartmentalisation of ammunition and other features. The silly season began in earnest when one widely circulated article suggested that the Army had hidden the real cost of the XM1 tank programme because it had not informed Congress that it was going to be obliged to buy an M9 ACE armoured engineer tractor for each XM1, since the tank had no bulldozer blade to entrench itself! Another popular myth of the day, fostered even by otherwise sober newspapers like the *New York Times*, was that the XM1 cost three times as much as the M60. In fact, it cost 30 per cent more than the M60A3, largely due to the higher cost of the armour and the more potent engine.

The Press controversy came close to scuttling the funding of the programme in the US Congress in 1981 and 1982. Luckily, Congressional opposition began to wane when the Army paraded a number of tankers from the test programme in front of Congressional hearings to express their own feelings about the XM1's merits and problems. The testimony of a bunch of tank sergeants went a much longer way towards preserving the programme than the droning reiteration of the 'party line' by the top brass. Most convincing of all was the

An M1 of 1/11 ACAV in 'Reforger '83' with its Blue Army marking ripping off. The narrow band across the lower edge of the turret sides and front is a Velcro strip used to attach the MILES laser training system. This tank is fitted with a pyrotechnic simulator over the barrel, which simulates the tank gun firing during exercises. (Pierre Touzin)



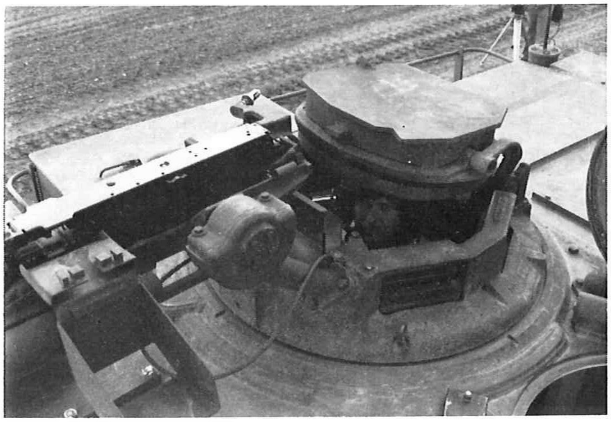
improvement in test results that indicated that engine reliability was steadily rising to acceptable levels. The one problem that remained was that the tracks were not reaching the desired life expectancy of 2,000 miles, but were wearing out in half that time. The Army admitted that the requirement itself may have been unrealistic and outside the capabilities of current track technology. The US Army still relies on rubber block tank tread in peacetime, due to its lower wear on roads and its reduction of vibration and noise in the tank itself. In wartime, less expensive steel tracks would be used.

The vulnerability of tank programmes like the XM1 to irresponsible Press witch-hunts is peculiar to the United States. US security restrictions are far less stringent than European restrictions. Indeed, it is almost inconceivable that a European programme would be put at risk in a similar fashion, as test results are a closely guarded secret.

Initial production and deployment

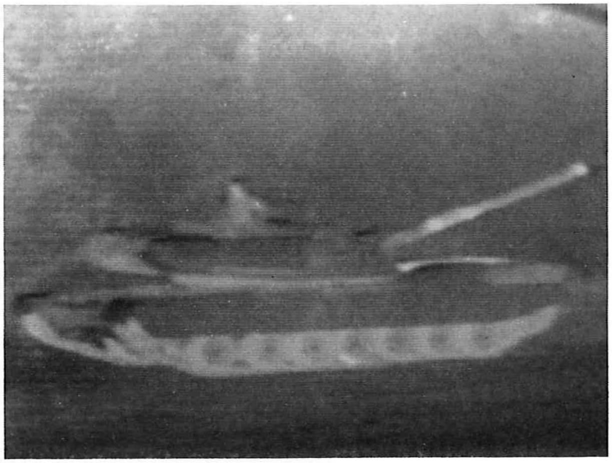
At the end of 1979 a go-ahead was given for initial low-rate production to begin, with the caveat that it would be slowed or halted if the 'fixes' suggested in the trials were not effective. Continuing tests led in February 1981 to the XM1's type classification as the M1 Abrams, after Gen. Creighton Abrams. (Abrams is perhaps best known as the commander of US forces in Vietnam, but among tankers he is remembered as the World War II commander of the 37th Tank Bn., 4th Armd. Div., arguably the finest US tank battalion of the war.) The first production batch began to be delivered in 1981. Although many of the inherent design flaws had been removed, problems persisted at the production end. Quality control at the engine production plant was inadequate; there were serious backlogs of engines and tank thermal sights; and the Army was wary of conducting vigorous tests due to possible political consequences. Full scale production was authorised in the fall of 1981 even though reliability requirements had not yet been proven. The Army was confident that its solutions to the problems would work, even if full testing would not be completed until 1983.

Deployment of the first M1 tanks with the 1st Cav. Div. and 2nd Armd. Div. at Ft. Hood, Texas went smoothly. Although technologically more sophisticated than the M60A3, the design of the M1 stressed ease of operation and repair, and this proved to be the case when the tank was issued to its crews. The fire control system of the M1 is very similar to the M60A3(TTS), if somewhat better integrated. Repair of the turbine engine proved a novel experience for maintenance crews. The AGT-1500 engine takes about one hour to remove and replace, compared to about four hours for an AVDS-1790 diesel in an M60A3. Because of the modular construction of the turbine, engine repairs are faster on the M1, and a much smaller number of engines is required. In the light of the progress with



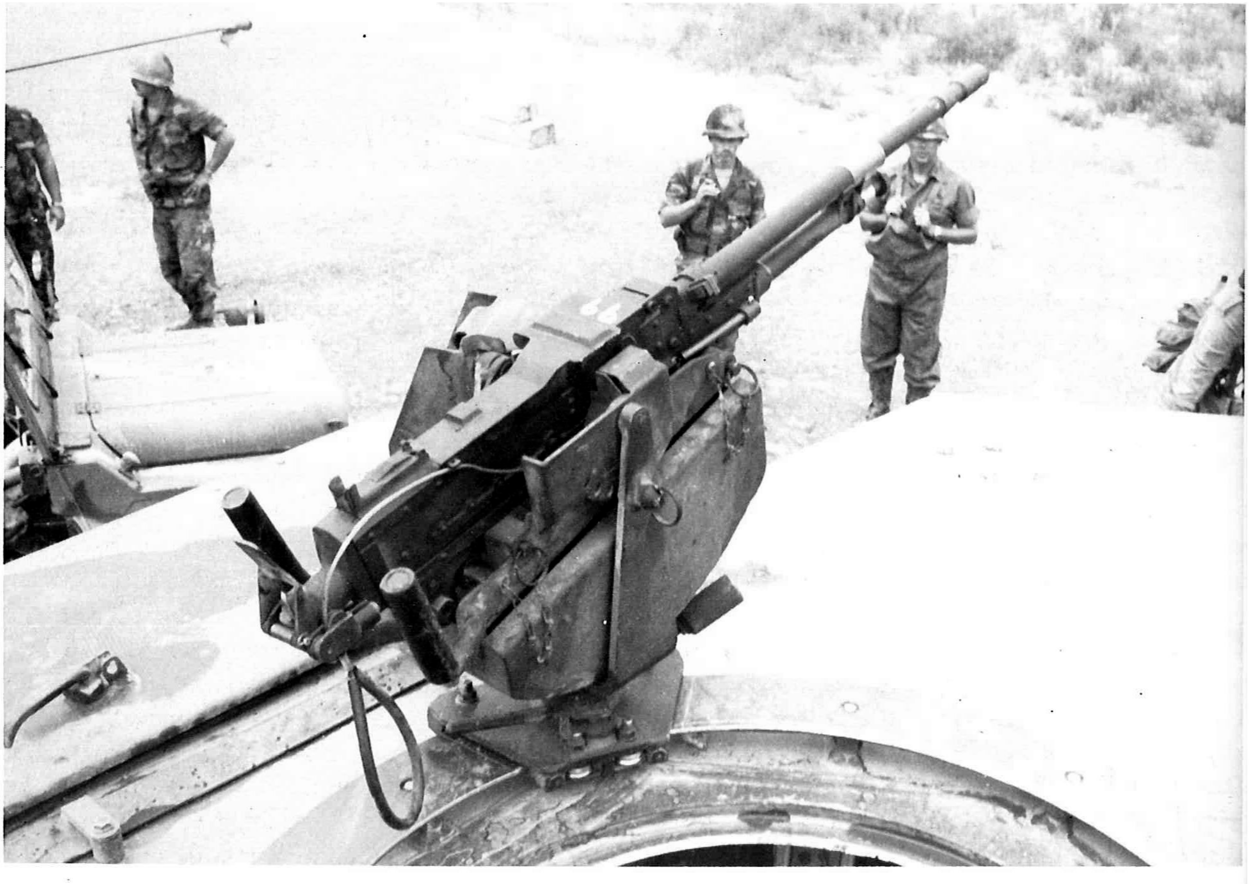
The M1 cupola hatch can be partially opened to allow the commander to peer out while at the same time enjoying overhead cover from artillery airbursts. (S. Zaloga)

A major advantage of newer NATO tanks over Warsaw Pact tanks is their use of thermal (FLIR) night sights. These passive sights detect the subtle infrared differences between troops and man-made objects and the lower background radiation. This view through a thermal imager shows an M1 Abrams. (US Army)

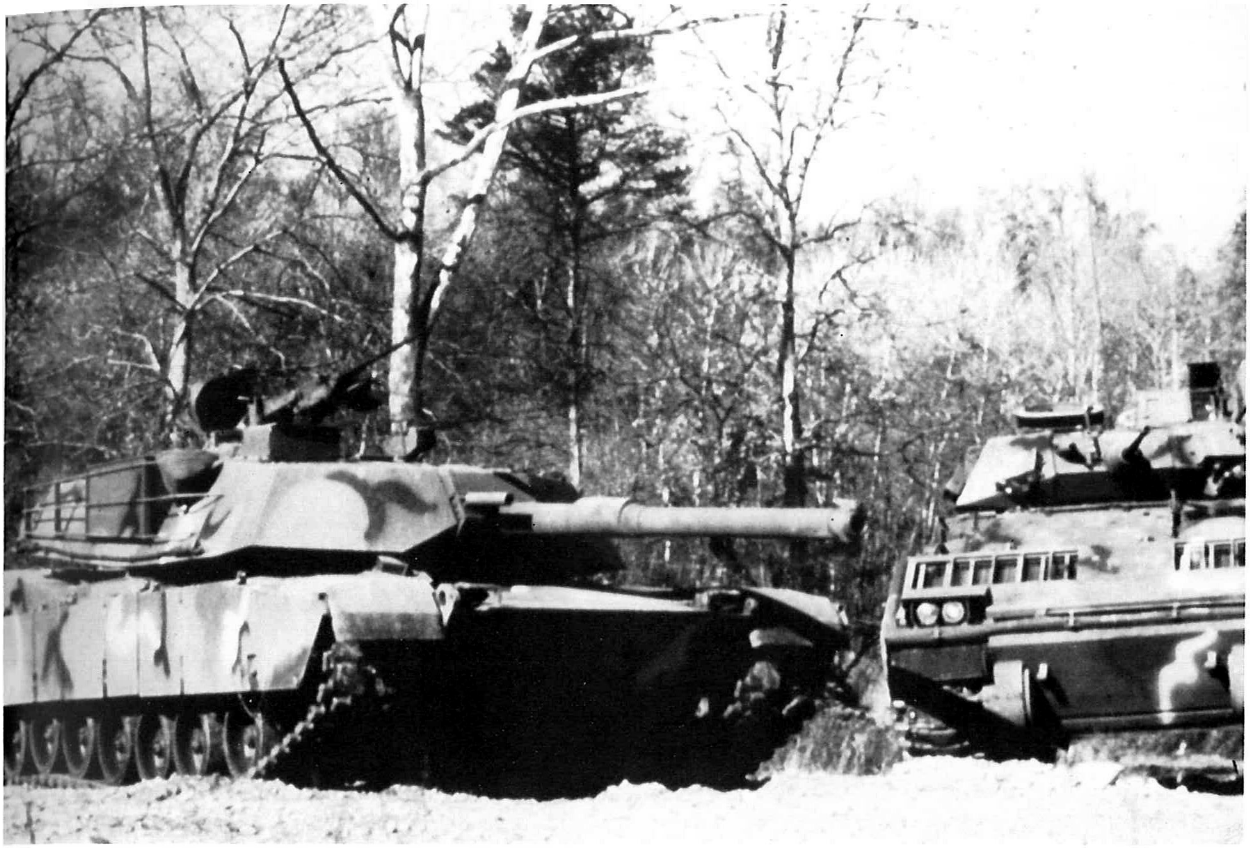


the programme, the first M1s began to be shipped to 64th Armor, 3rd (Mech.) Inf. Div. in Germany in the fall of 1981. The Army intended to deploy the first M1 tank battalions in the autumn 1982 'Reforger' exercises, to demonstrate the performance of the M1 in conditions more akin to combat than the somewhat artificial engineering trials.

Much to the Army's relief, the M1's performance in the 1982 'Reforger' exercise was a smashing success. The M1 was greeted with considerable enthusiasm by the US tankers in Germany, who were no longer amused by taunts from German Leopard crews about their arthritic M60A1s. Not only did the M1 have the automotive performance to satisfy even the most puerile fantasies of its crews, but the Army took great pains to explain the effectiveness of the M1's new armour configuration. The crews were shown a classified film taken at APG of one of the 11 pre-production XM1s being subjected to a wide variety of Soviet tank guns, missiles, rockets and mines. These weapons would have destroyed an M60A1, but the XM1 was consistently driven away, if occasionally requiring minor repairs by its crew. In public testimony before Congress in 1983, Army representatives cryptically alluded to the fact that the M1 'had demonstrated a 100 per cent improvement in survivability over the M60.' A quick translation from Army bureaucratese indicates that in firing trials, hits on the XM1 that would have killed the crew of an M60 resulted in no crew loss in the XM1. Fortunately, the Army was somewhat more forthcoming to Congress in closed, secret hearings. In contrast to the previous year's hostility to the programme, in 1983 Congress actually insisted that the Army purchase more M1s than they had requested!



The M240 loader's machine gun on the M1. This is a licence-built version of the Belgian FN machine gun. Besides this Belgian gun, the M1 uses a British-designed main gun, British-designed armour and a British-designed smoke mortar system. (S. Zaloga)



The M1's new stablemates are the M2 Bradley Infantry Fighting Vehicle and the M3 Cavalry Fighting Vehicle, which are nearly identical externally. (US Army)

Reforger '82

The annual NATO 'Reforger' exercises held across the breadth of Germany each autumn are the main tactical exercises of the NATO tank forces. Fictitious Orange and Blue armies, composed of units from different NATO countries, fight mock battles to test their tactical skills, and the ability of their logistics units to repair and maintain them. 'Reforger '82' was the first time the M1 Abrams was involved in such a demanding series of tactical exercises. The battalions of the 64th Armor were committed mainly to the 'Blue' Army.

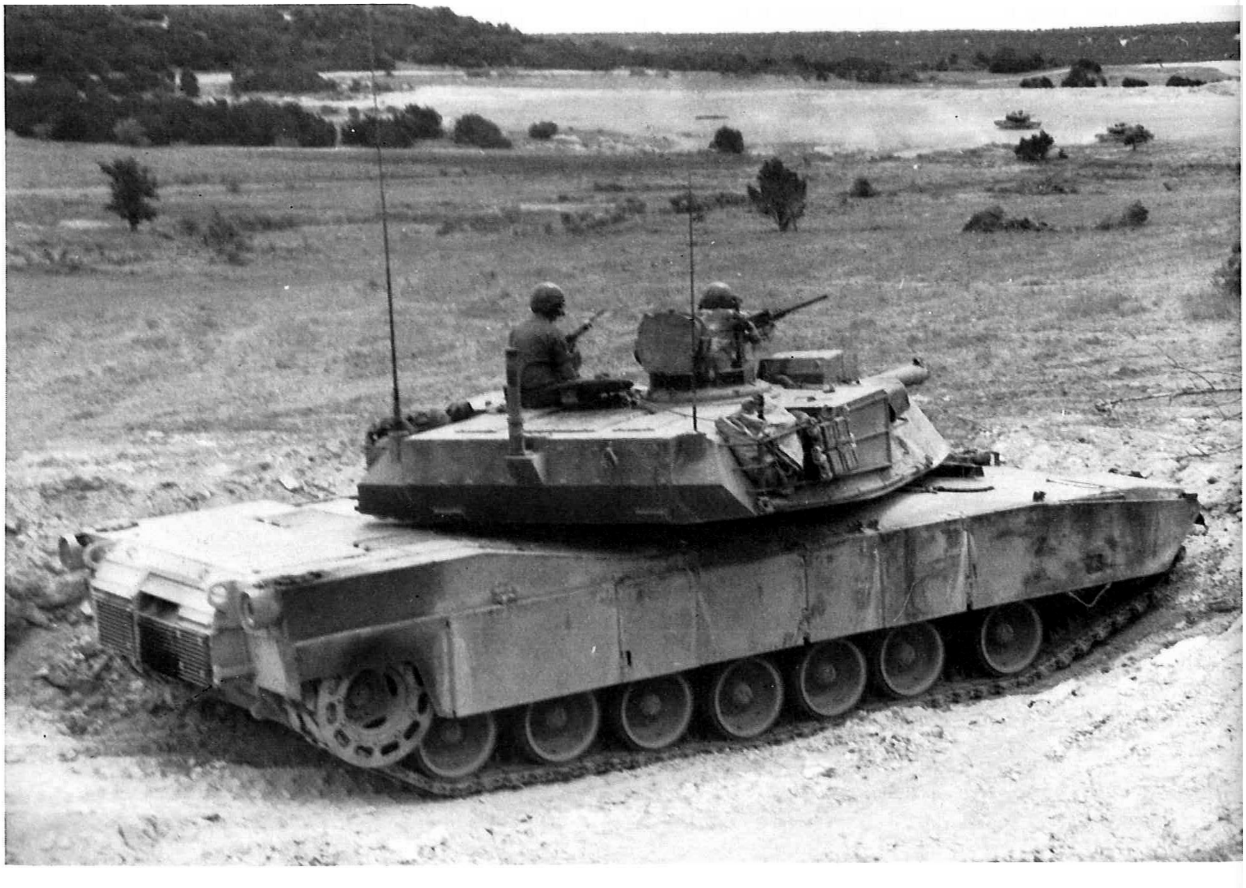
At dawn on the morning of 13 September 1982 a Canadian 'Orange' task force, consisting of a mechanised infantry company backed by several Leopard I tank companies, began 'attacks' against opposing Blue forces. The main defence line of the Blue 3rd Inf. Div. (US) was met, and 'battle' was joined with elements of the 2/30 Infantry outside Dingolhausen, FRG. About noon a Canadian infantry platoon deep in the rear of the friendly Orange forces began moving forward to assist in clearing out stubborn American resistance at Dingolhausen. While passing through a wooded area far outside the battle area, it stumbled on to a tank battalion hidden in the woods. The tanks were slab-sided, like the later-model Canadian Leopard Is; but more ominously, they carried on the turret fronts the bright blue marker squares that characterised them as 'enemy' Blue Army tanks. The Canadian platoon was quickly 'wiped out'.

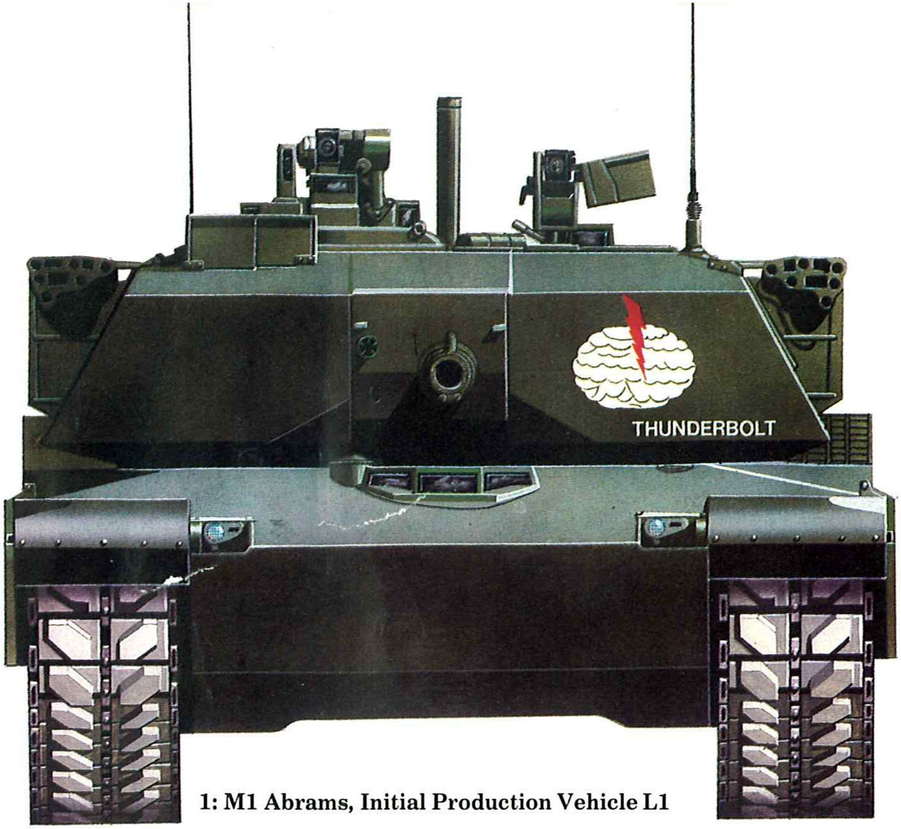
The commander of the hidden Blue tanks informed division that his concealed position had been discovered. Although forced to launch its counter-attack prematurely, his ruse had worked. Most of the 'enemy task force' had flowed by without noticing his tanks. Now it was time to take advantage of the Canadian Orange troops' mistake. Lt.Col. John Kelsey ordered his tanks to prepare for action. To the delight of the tankers, their M1s could hardly be heard by the dismounted guards at the wood's edge due to the quiet turbine engine. More appealing was the tanks' response as the battalion charged out into the open.

One of the M1 companies charged into a Canadian mechanised infantry company which was riding into action on M113 APCs. The Canadians were 'wiped out' before they could react. The second Abrams company was ordered to swing further out from the woods to attack the Leopard company supporting the infantry. The Leopards were caught with their pants down as they were refuelling at a POL point. Nine Leopards lined up in a neat row suddenly became victims, with their rotating amber manoeuvre beacons signalling defeat. With two of the M1 companies engaged, the third Abrams company homed in on another Leopard company attacking 2/30 Infantry at Dingolhausen. They struck unexpectedly from the rear; and there were suddenly a lot more static Leopards littering the German plains. For the *coup de grace* the second M1 company, after bypassing its victims at the POL point, swung behind another Canadian Leopard company attacking towards the Blue force lines. The company commander radioed to supporting AH-1S TOW Cobra attack helicopters lurking in hover behind the tree line of the Steigerwald on the Canadians' right flank. The Cobras popped up and began missile attacks on the Leopards, while the M1s simultaneously attacked them from the rear. The result: Orange Task Force wiped out. One of the Canadian officers later recalled: 'One minute it's quiet, with no contact; the next minute you are overwhelmed – swamped with quick, whispering death.'

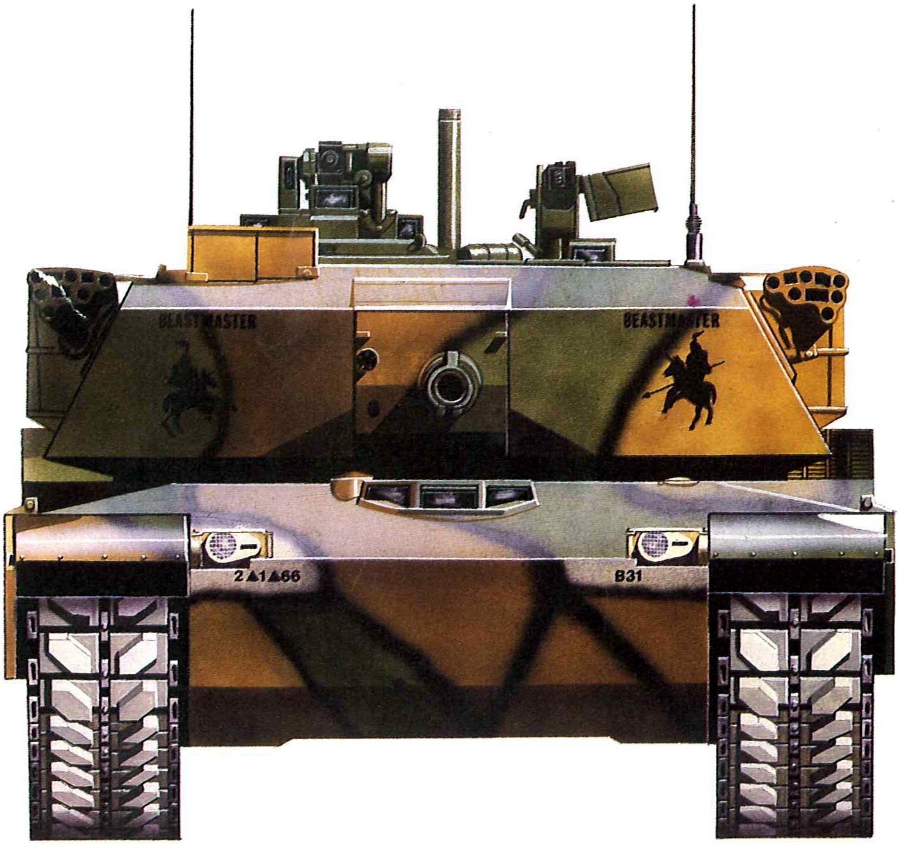
The commander of the 3rd Inf. Div., Maj.Gen. F. K. Mahaffey, summarised his feelings about the M1's performance in 'Reforger '82': 'Oper-

The new Div-86 tank platoon has four tanks which operate in pairs. In this view of 2nd Armd. Div. exercises on the Texas prairies, two M1s (one outside the photo) stand overwatch positions behind terrain features with only their turrets exposed, while the other pair of Abrams, in the upper right of the photo, move forward at top speed. (S. Zaloga)




THUNDERBOLT

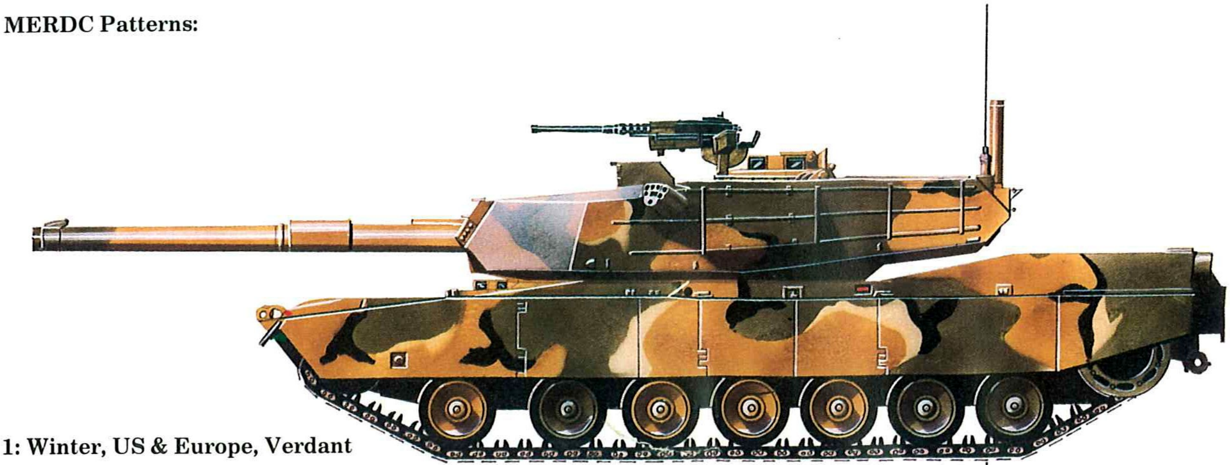
1: M1 Abrams, Initial Production Vehicle L1


BEASTMASTER
BEASTMASTER
2▲1▲66
B31

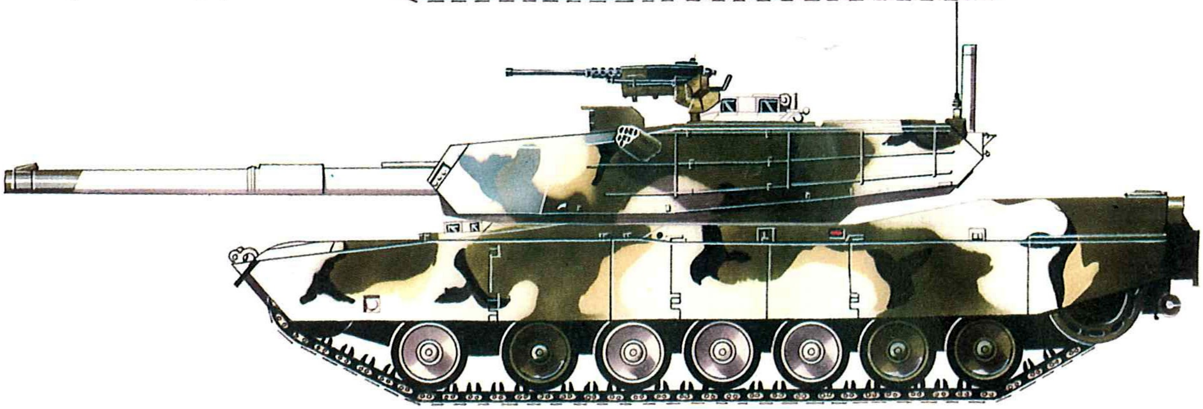
2: M1 Abrams, 1/66th Armor, 2nd Armd.Div., 1983

A

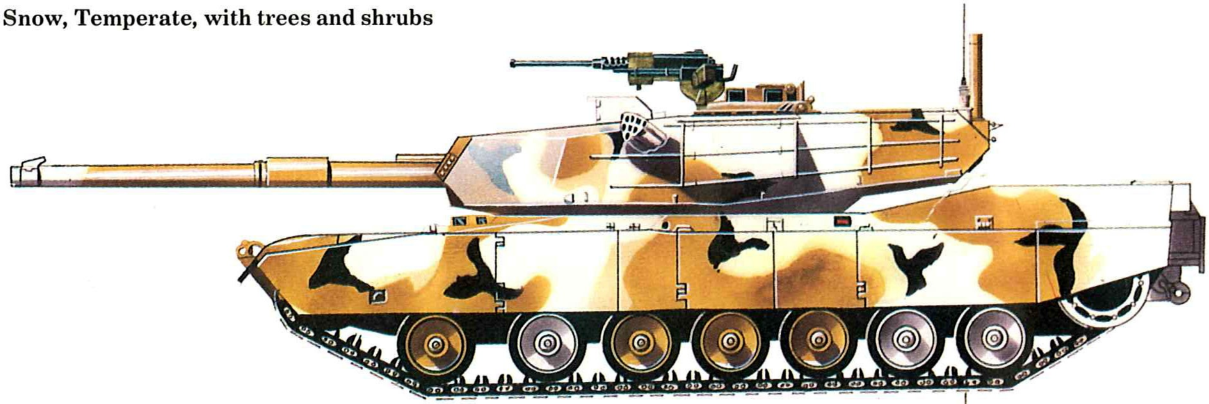
MERDC Patterns:



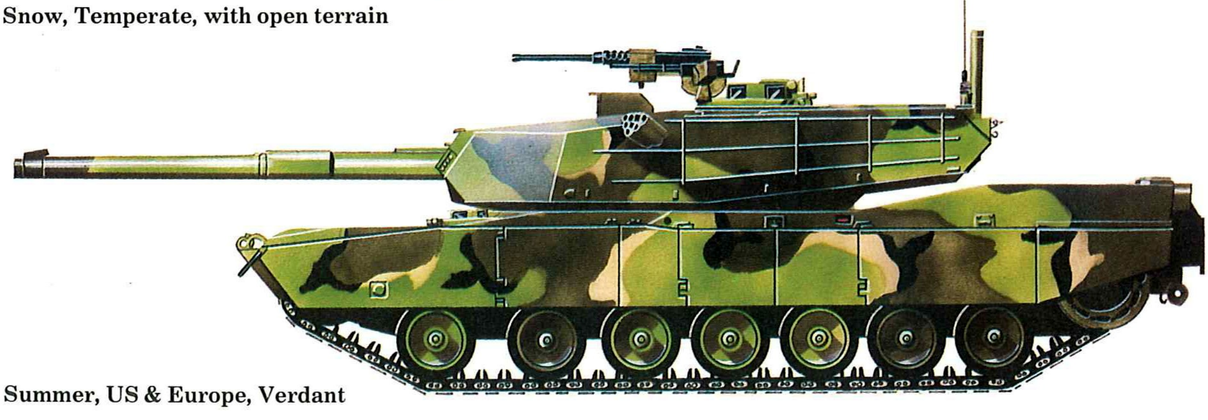
1: Winter, US & Europe, Verdant



2: Snow, Temperate, with trees and shrubs



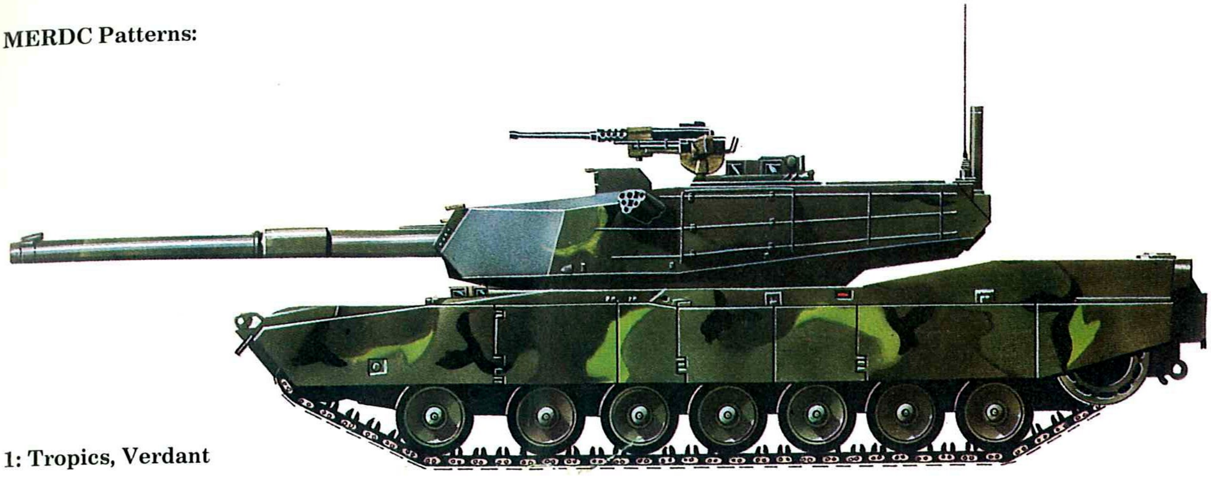
3: Snow, Temperate, with open terrain



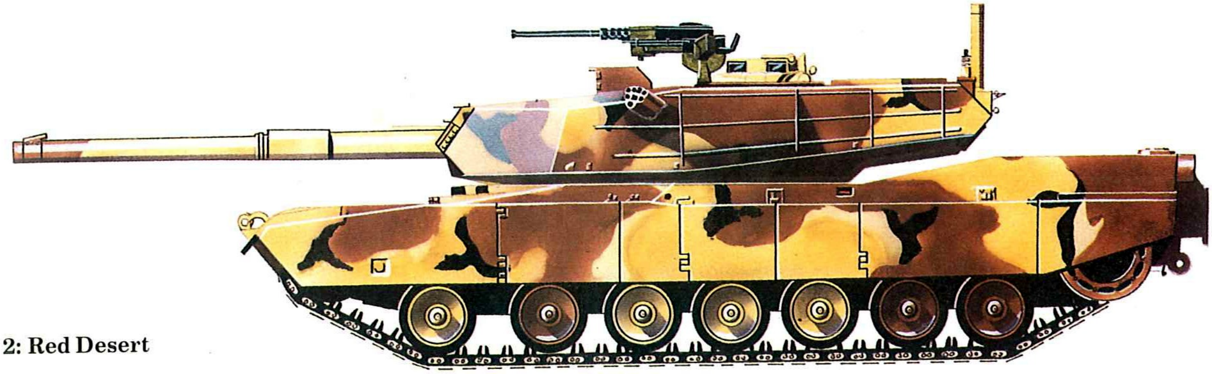
4: Summer, US & Europe, Verdant

B

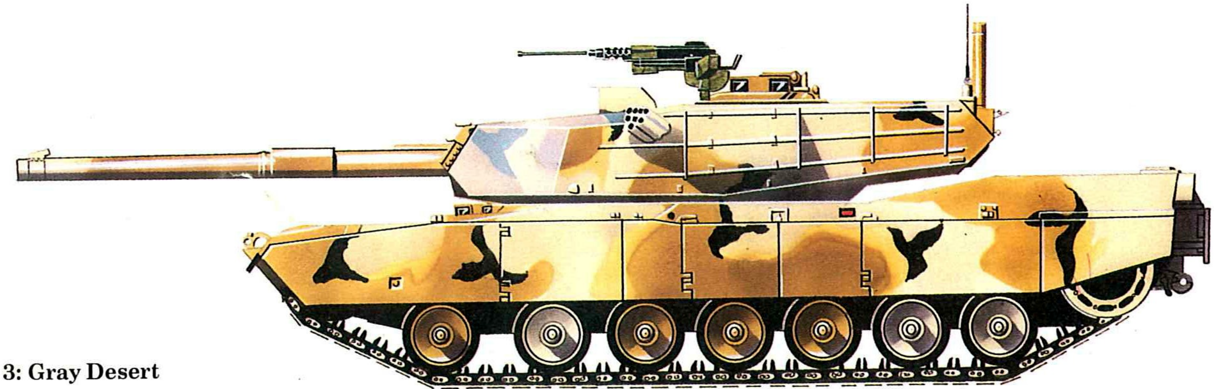
MERDC Patterns:



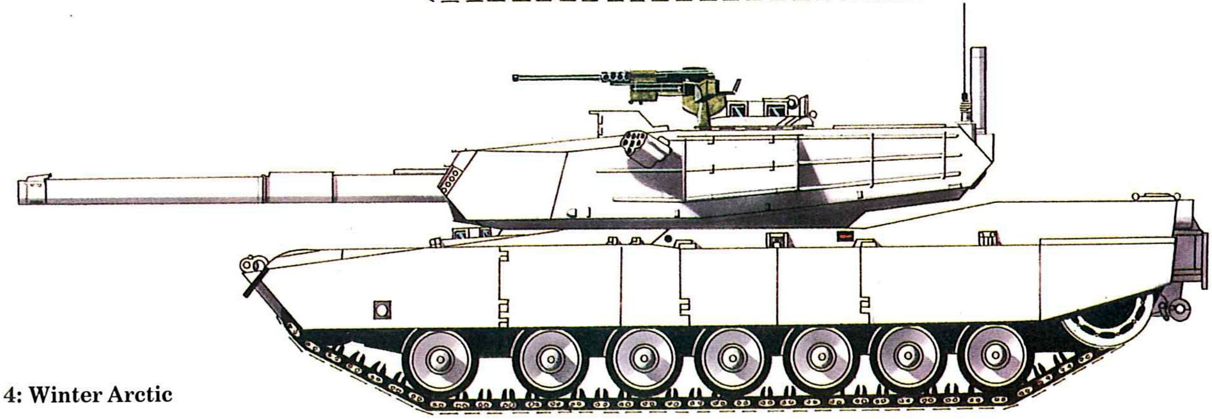
1: Tropics, Verdant



2: Red Desert

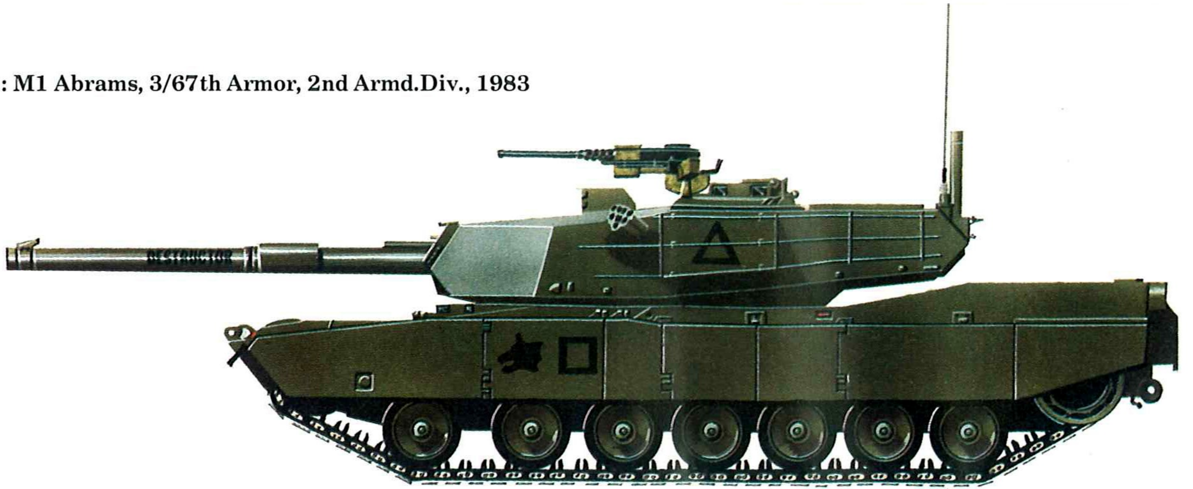


3: Gray Desert

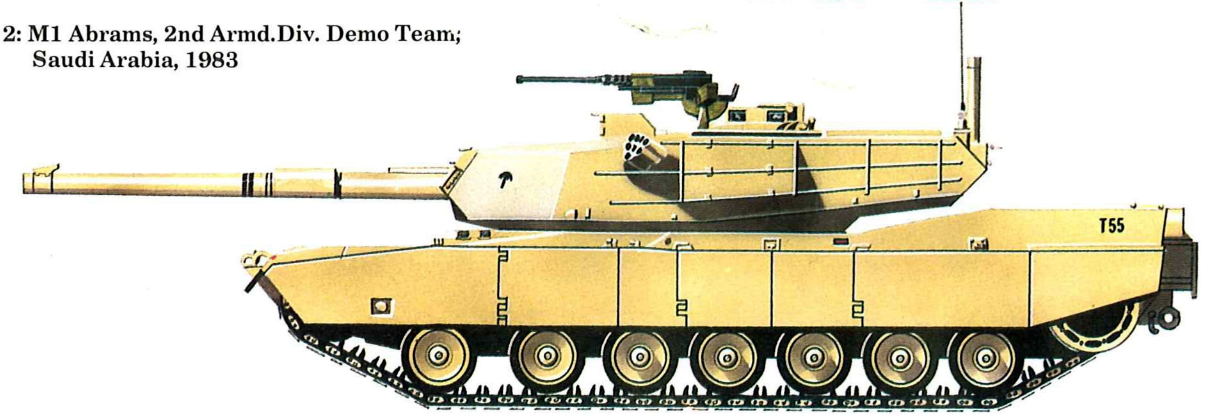


4: Winter Arctic

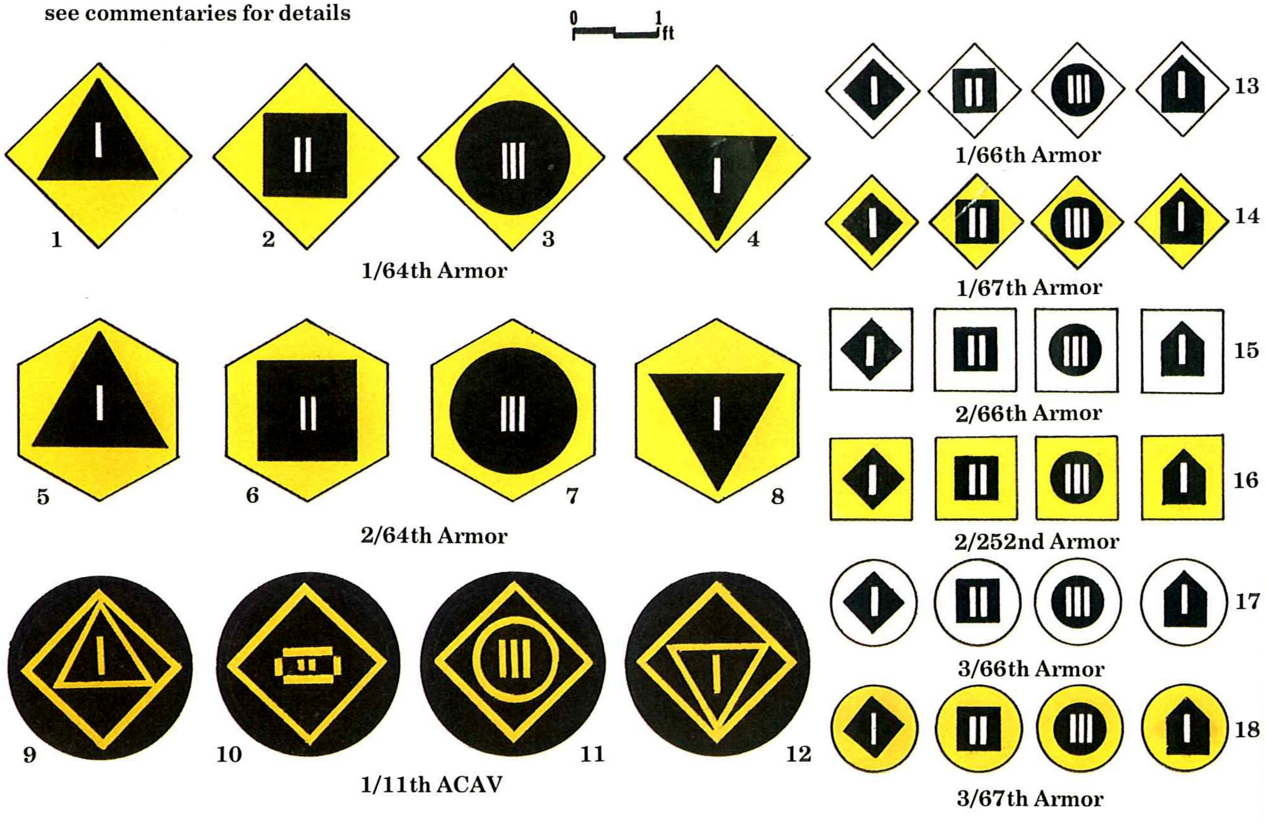
1: M1 Abrams, 3/67th Armor, 2nd Armd.Div., 1983



2: M1 Abrams, 2nd Armd.Div. Demo Team; Saudi Arabia, 1983

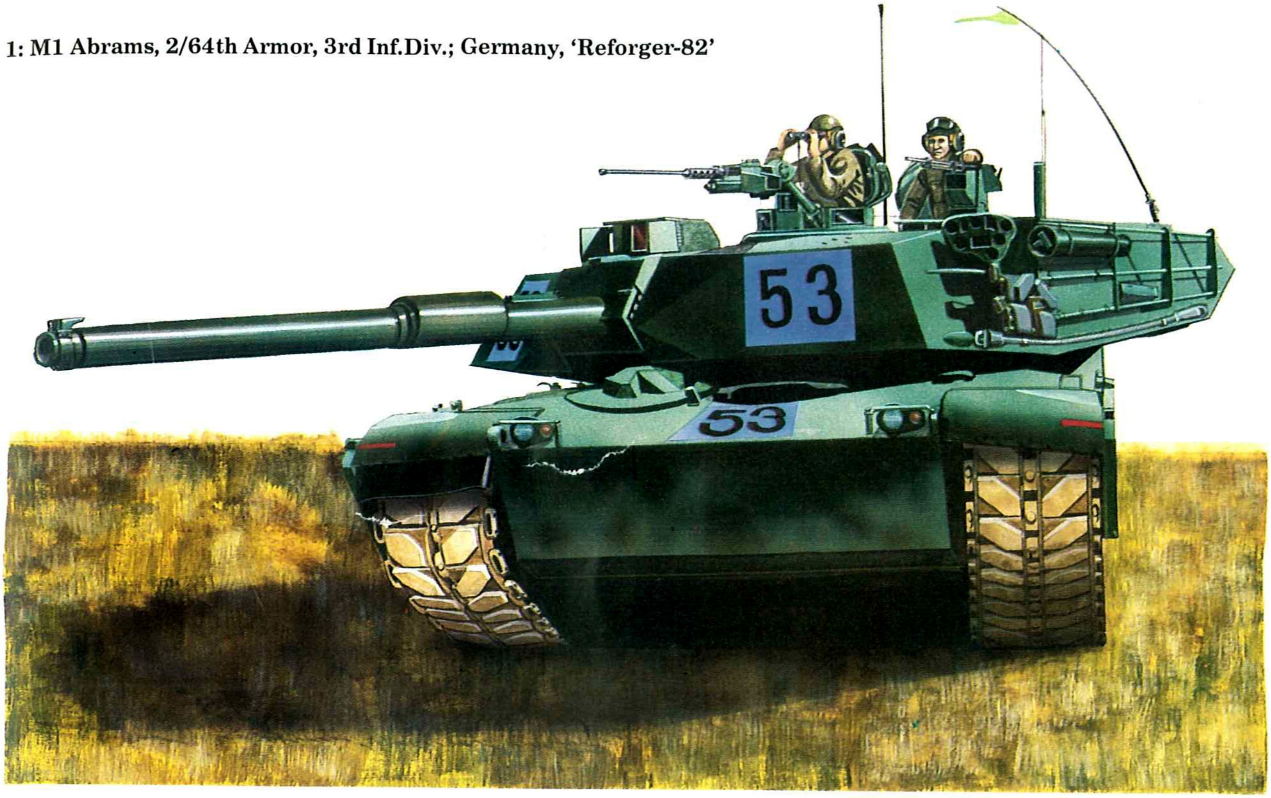


3: Regimental Insignia – see commentaries for details

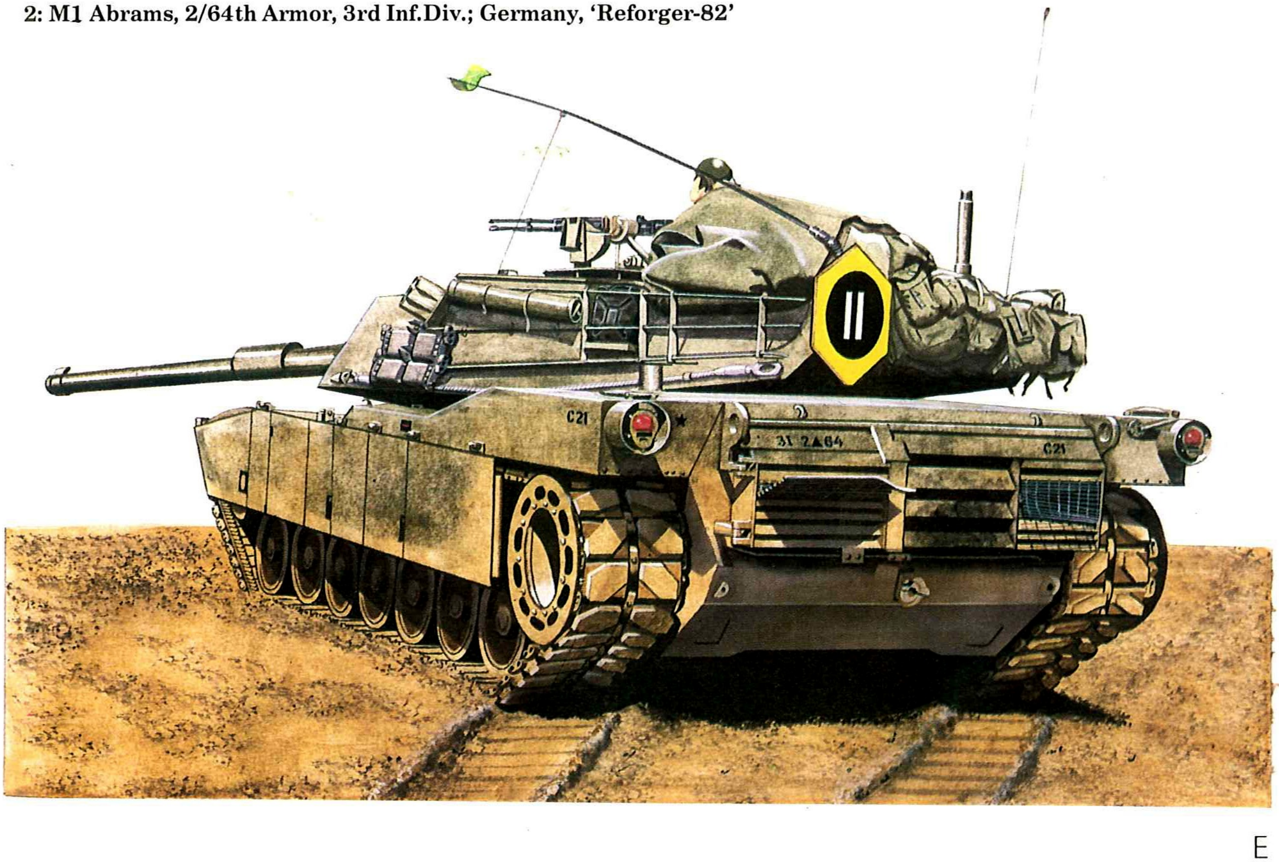

0
1
ft
1
2
3
4
1/64th Armor
5
6
7
8
2/64th Armor
9
10
11
12
1/11th ACAV
13
1/66th Armor
14
1/67th Armor
15
2/66th Armor
16
2/252nd Armor
17
3/66th Armor
18
3/67th Armor

D

1: M1 Abrams, 2/64th Armor, 3rd Inf.Div.; Germany, 'Reforger-82'

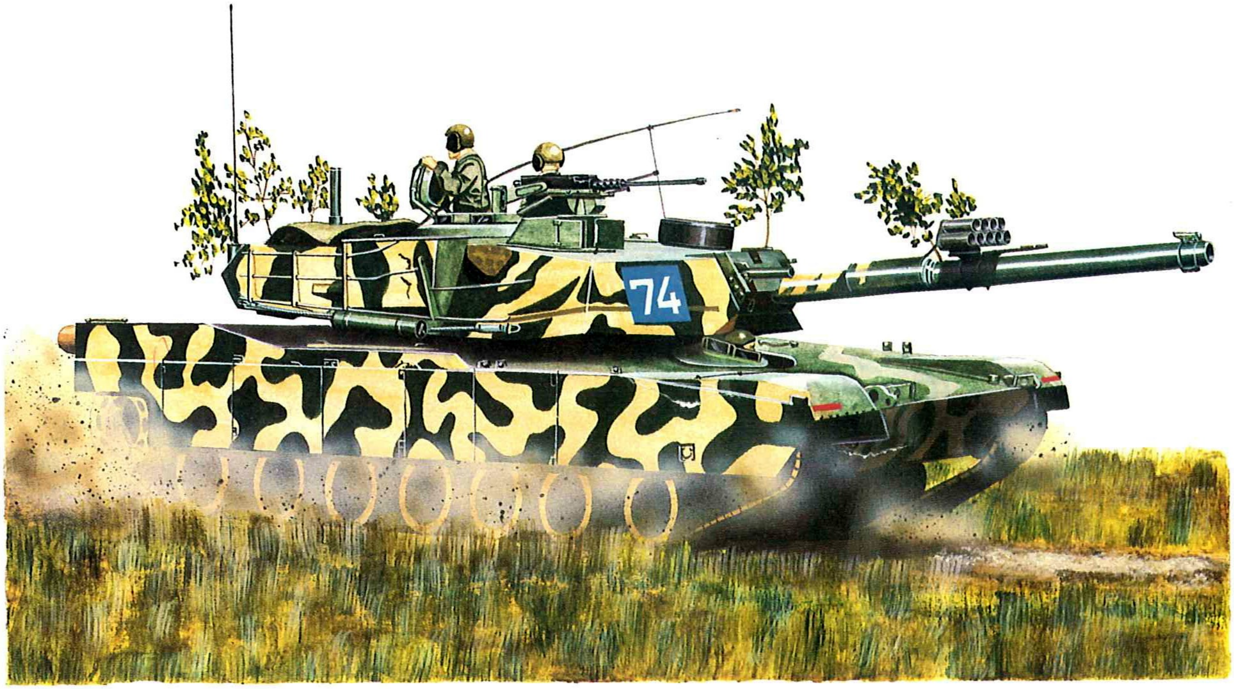


2: M1 Abrams, 2/64th Armor, 3rd Inf.Div.; Germany, 'Reforger-82'

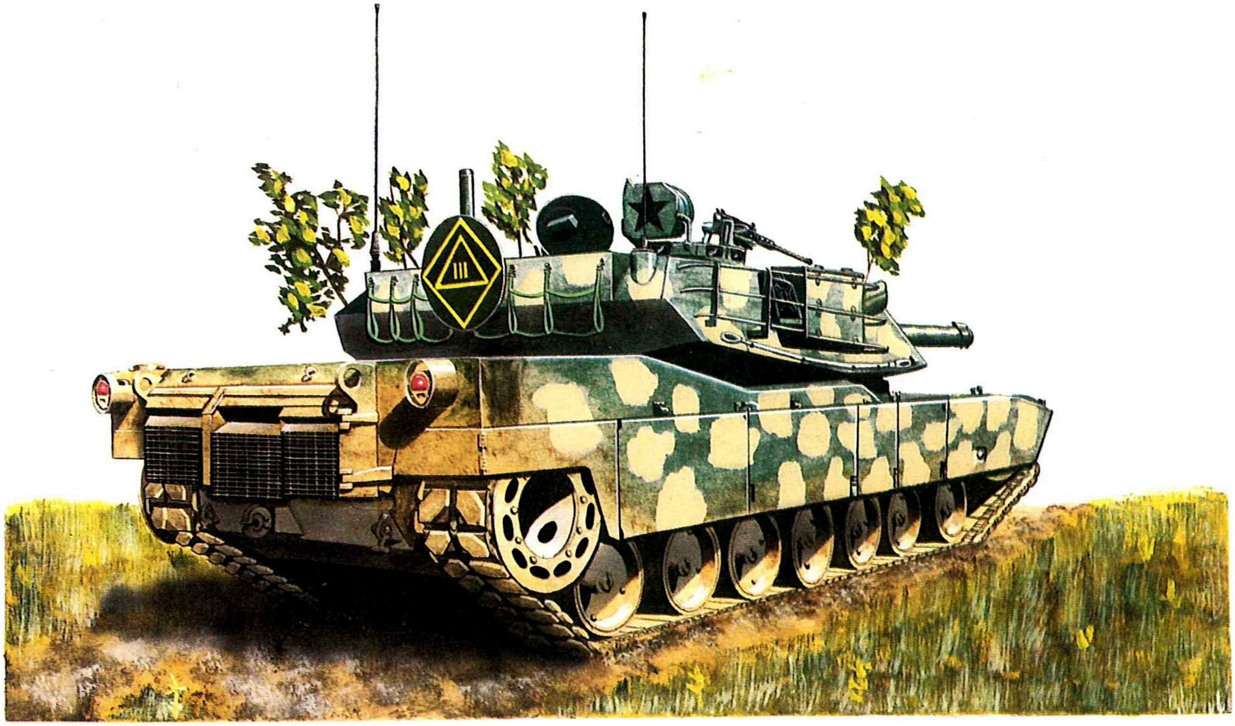

II
C21
3I 2▲64
C21

E

1: M1 Abrams, 1/11th ACAV; Germany, 'Reforger-83'

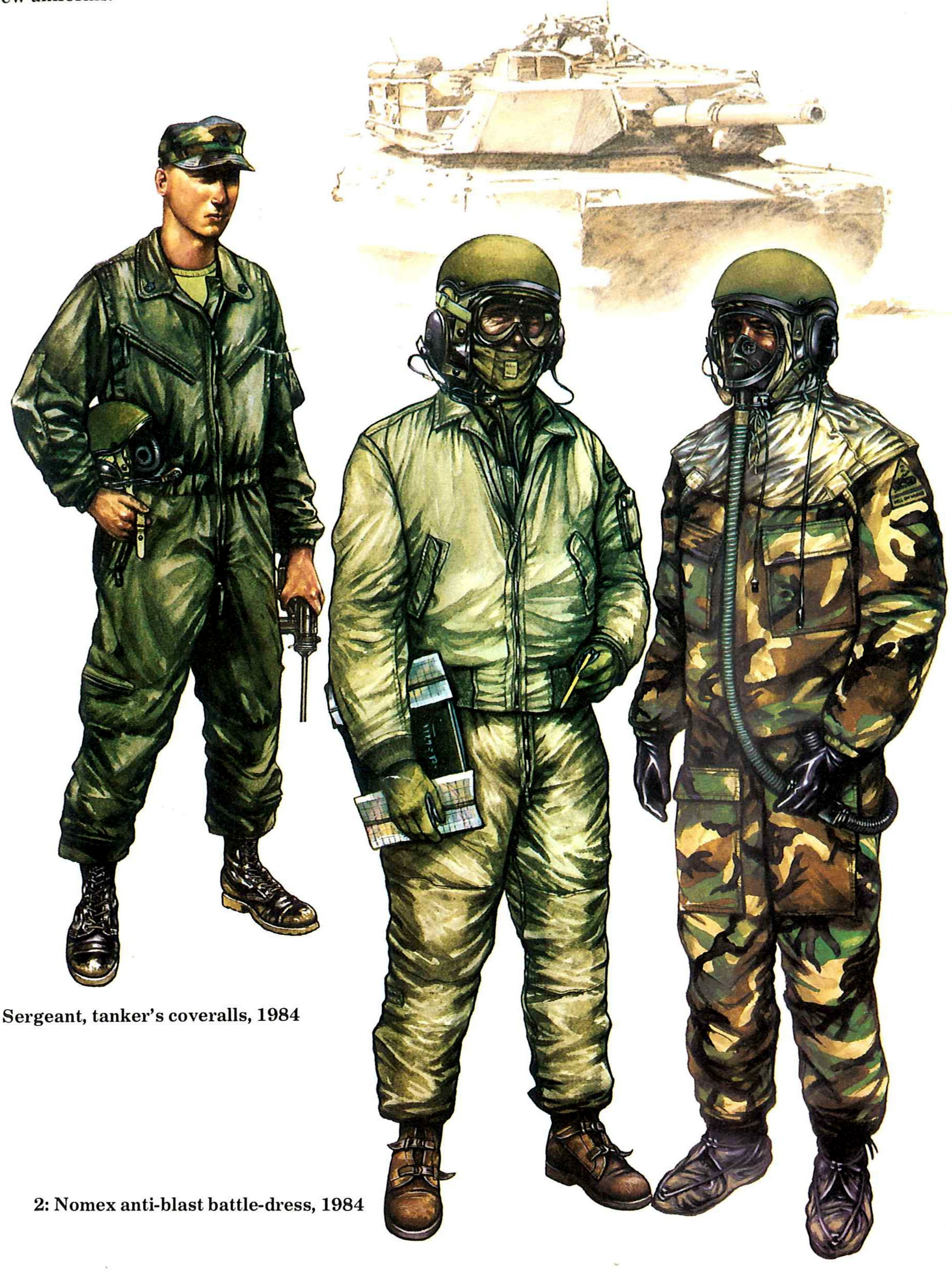


2: M1 Abrams, 1/11th ACAV; Germany, 'Reforger-83'



F

Crew uniforms:

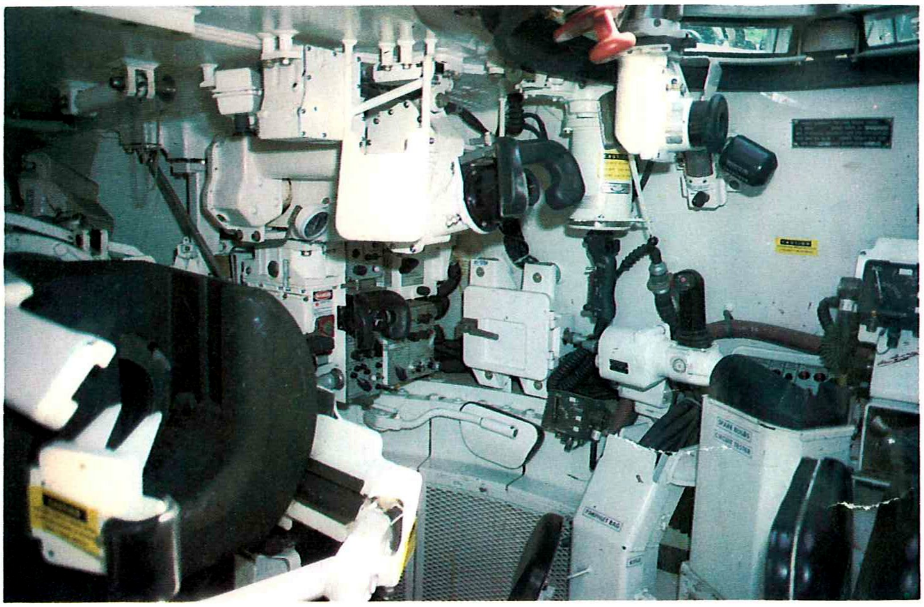


1: Sergeant, tanker's coveralls, 1984

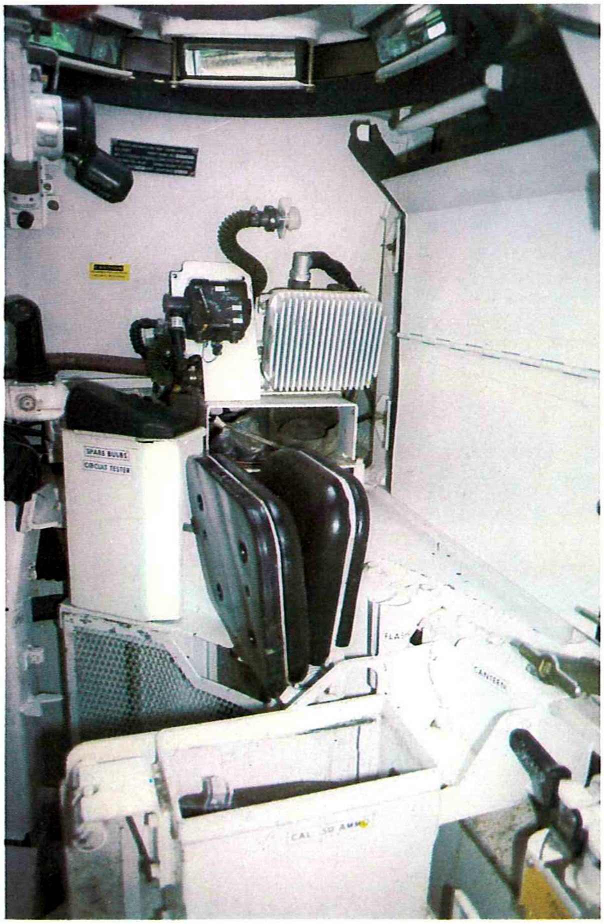
2: Nomex anti-blast battle-dress, 1984

3: CBR battle-dress, 1984

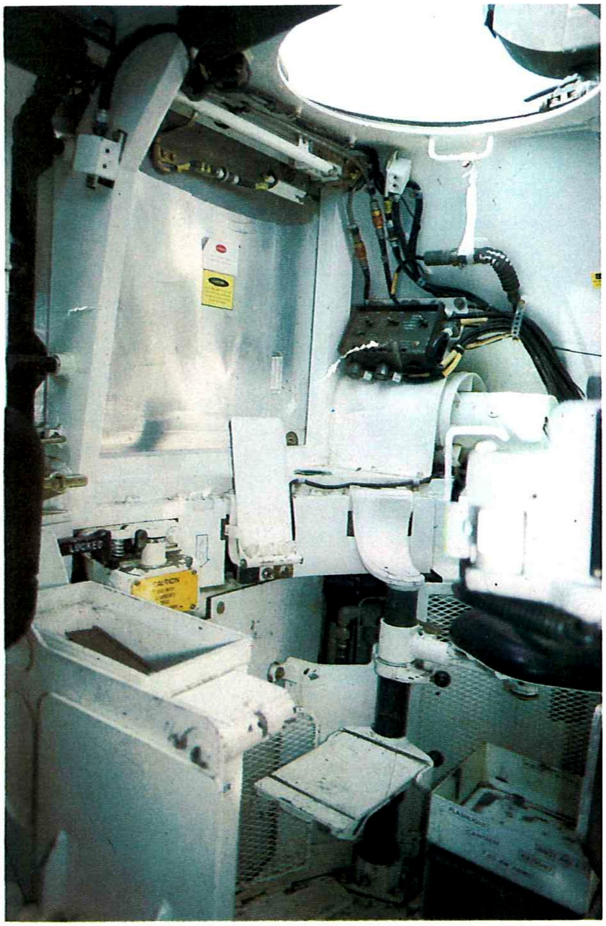
G


SPARE BULBS
CIRCUIT TESTER

1: M1 Abrams gunner's station

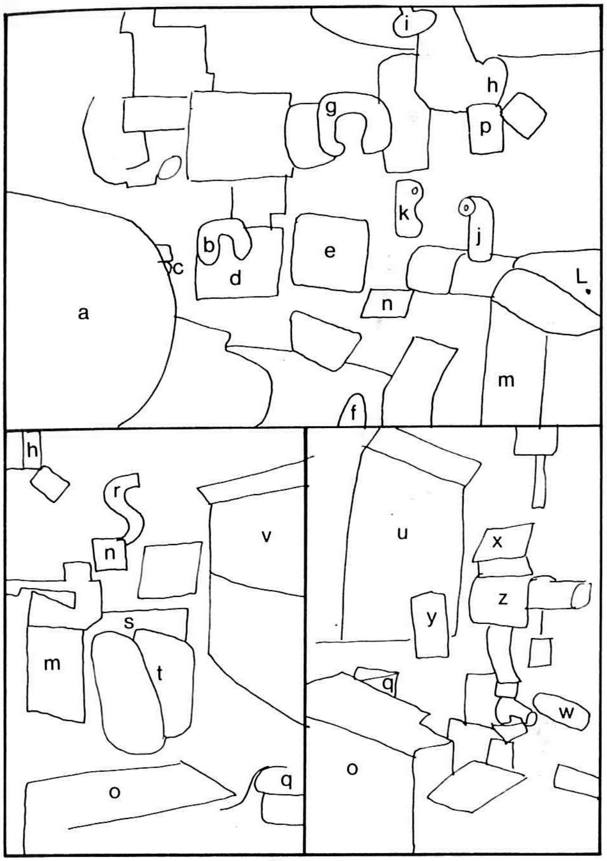

SPARE BULBS
CIRCUIT TESTER
FLASH
CANTEEN
CAL .50 AMMO

2: Tank commander's station


LOCKED
CAUTION

3: Loader's station

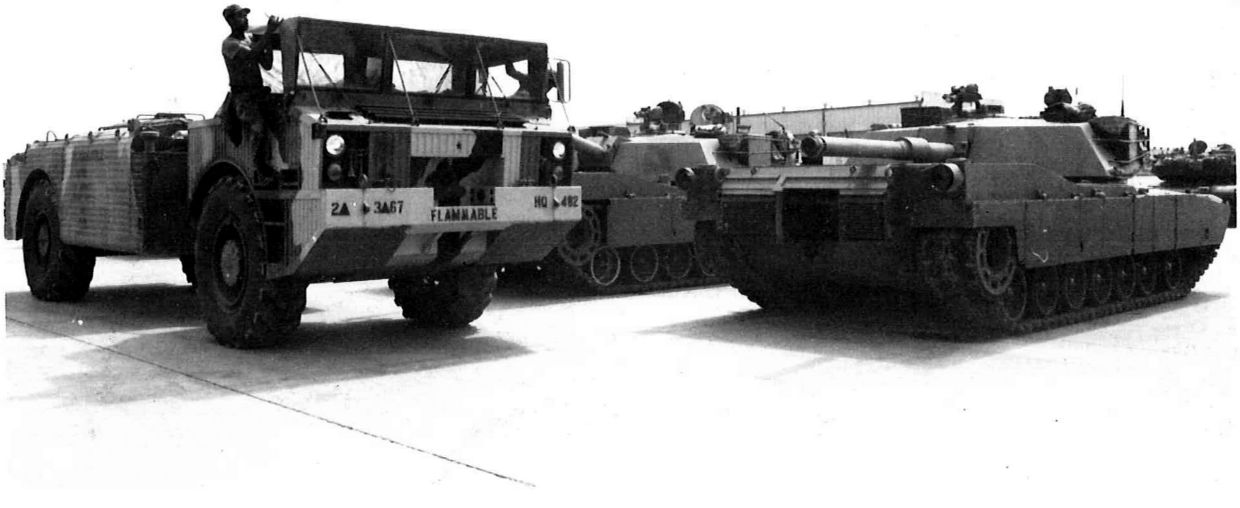
H



Key to Plate H opposite:
(a) M68A1 105 mm main gun
(b) Gunner's Tank Integrated Sight (TIS)
(c) Gunner's telescopic sight
(d) Gunner's controls
(e) Computer controls (cover closed)
(f) Gunner's seat
(g) Tank commander's (TC's) main sight
(h) TC's machine gun sight
(i) TC's cupola traverse
(j) TC's main gun control
(k) TC's azimuth control
(l) TC's grenade-launch panel
(m) Stowage
(n) Intercom control
(o) MG ammo stowage
(p) Turret dome light
(q) Turret lock
(r) TC's CBR hose and filter
(s) Voice security unit (not fitted)
(t) TC's seat, folded
(u) Left ammo blast door
(v) Right ammo blast door
(w) Loader's seat
(x) Loader's intercom control
(y) Knee control for blast doors, folded
(z) Turret blower

ationally, the M1 exceeded our expectations during "Reforger". The fighting capability of the system proved to be so much more than previously assumed that it required a new perspective on mounted combat . . . During the exercise, there was an initial tendency to treat it as "just another improved tank". But all this changed as the exercise evolved and the full potential of the M1 became apparent to all. The umpire adjudication process served to highlight a mindset existing among too many that the tactics and employment of the M1 units should conform to the doctrine developed for the much slower, less survivable M60 tanks. In this

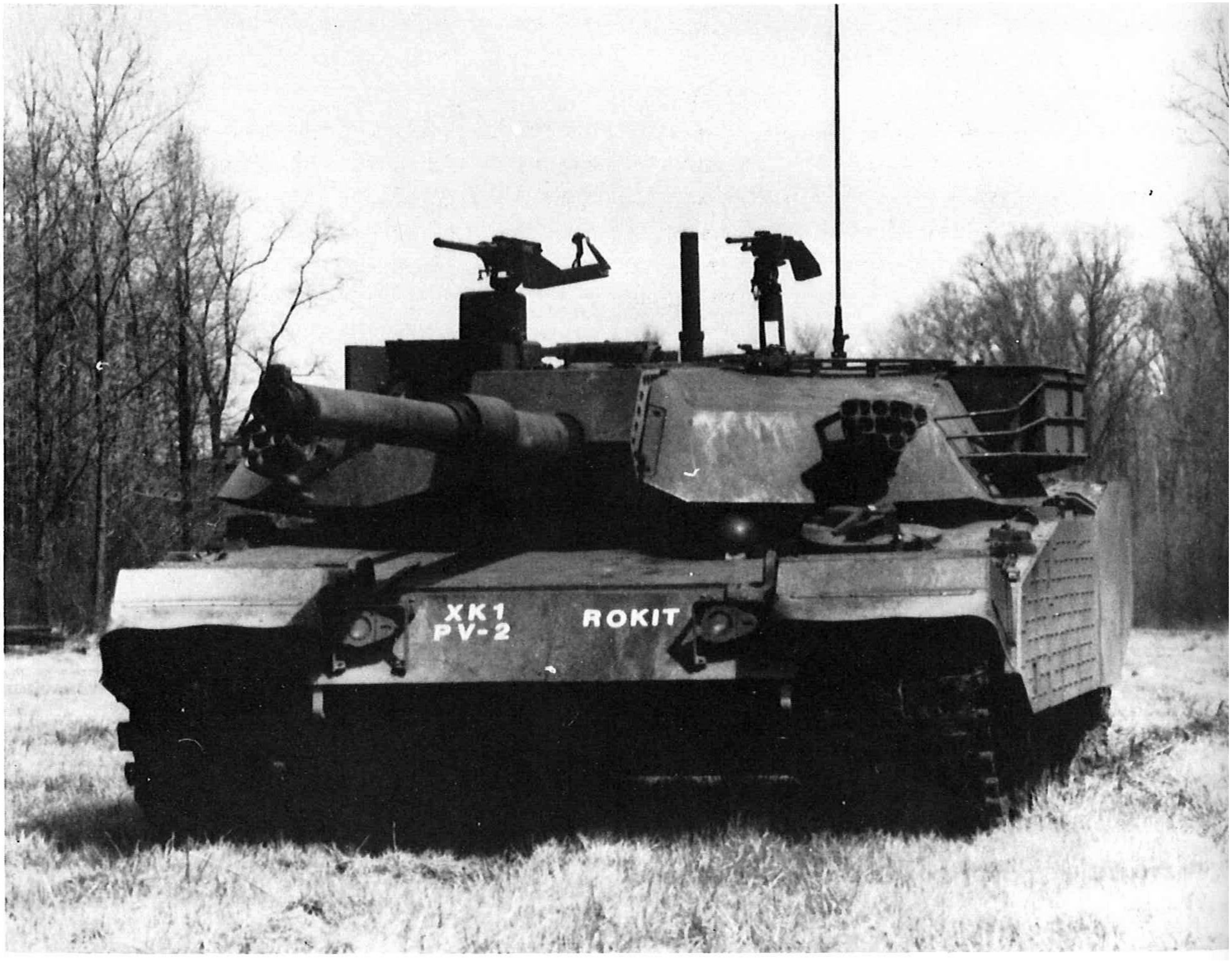
M1s being refuelled by M559 Goers. The Goers will eventually be replaced by the newer HEMTT 10-ton trucks. A single fuelling of the M1 gives it over 200 miles range, depending on terrain, which is about the same as the M60A3. (S. Zaloga)



regard it is important for all to understand that what makes the M1 units truly different – by an order of magnitude – is the tank's extraordinary capability to fire while moving at high speeds [30–40 mph] with an accuracy and effectiveness, by day or night, at least equal to that of an M60 firing from a stationary position.'

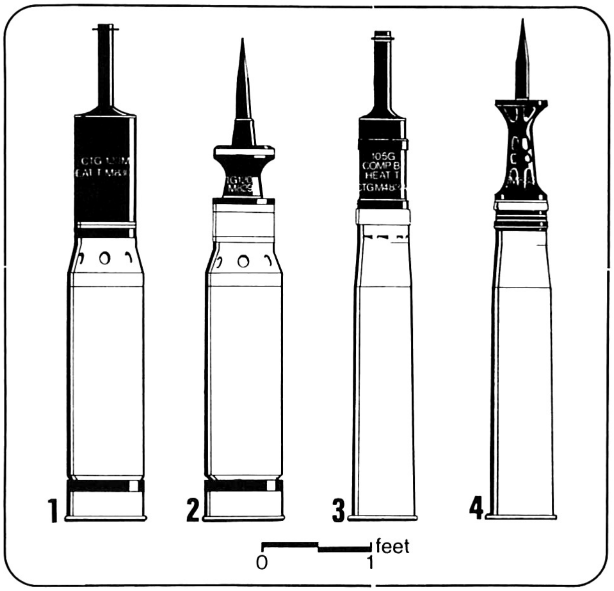
These views were shared by the tankers as well. SFC J. Fields, a platoon leader with 2/64th Armor: 'As we swung and faced the enemy you could see the mass confusion they were in, with the tracks [M113s] and tanks nearly bumping into each other trying to get out of there. They were totally caught by surprise . . . It's just remarkable that you could have four tanks running in pattern with the gun tubes oriented in the right direction and moving at 40 mph.' The commander of 1/64th Armor, Lt.Col. J. Quinn: 'The second day was the most devastating. We had two of my companies and the 3/64th Armor attacking on line in Bowling Alley West. That was a magnificent sight. We just completely overwhelmed the Orange forces. There was nothing they could have thrown up there to keep our two battalions from rolling right on through . . . They absolutely could not react to the speed of that tank no matter how hard they tried. And I know that they tried harder and harder every day to plug their holes, but once we found the hole we were through it and in their rear so fast they just could not react. We kept them disrupted, confused and just generally frustrated for three days.' One tank loader added: 'It seemed like the enemy didn't have a chance, even though they had us outnumbered.'

An M1 look-alike is the South Korean XK1 ROKIT tank, developed in the USA by GDLS for production in Korea. It is about two-thirds the size of the M1, and is noticeably smaller inside. (APG Public Affairs)



Inside the M1 Abrams

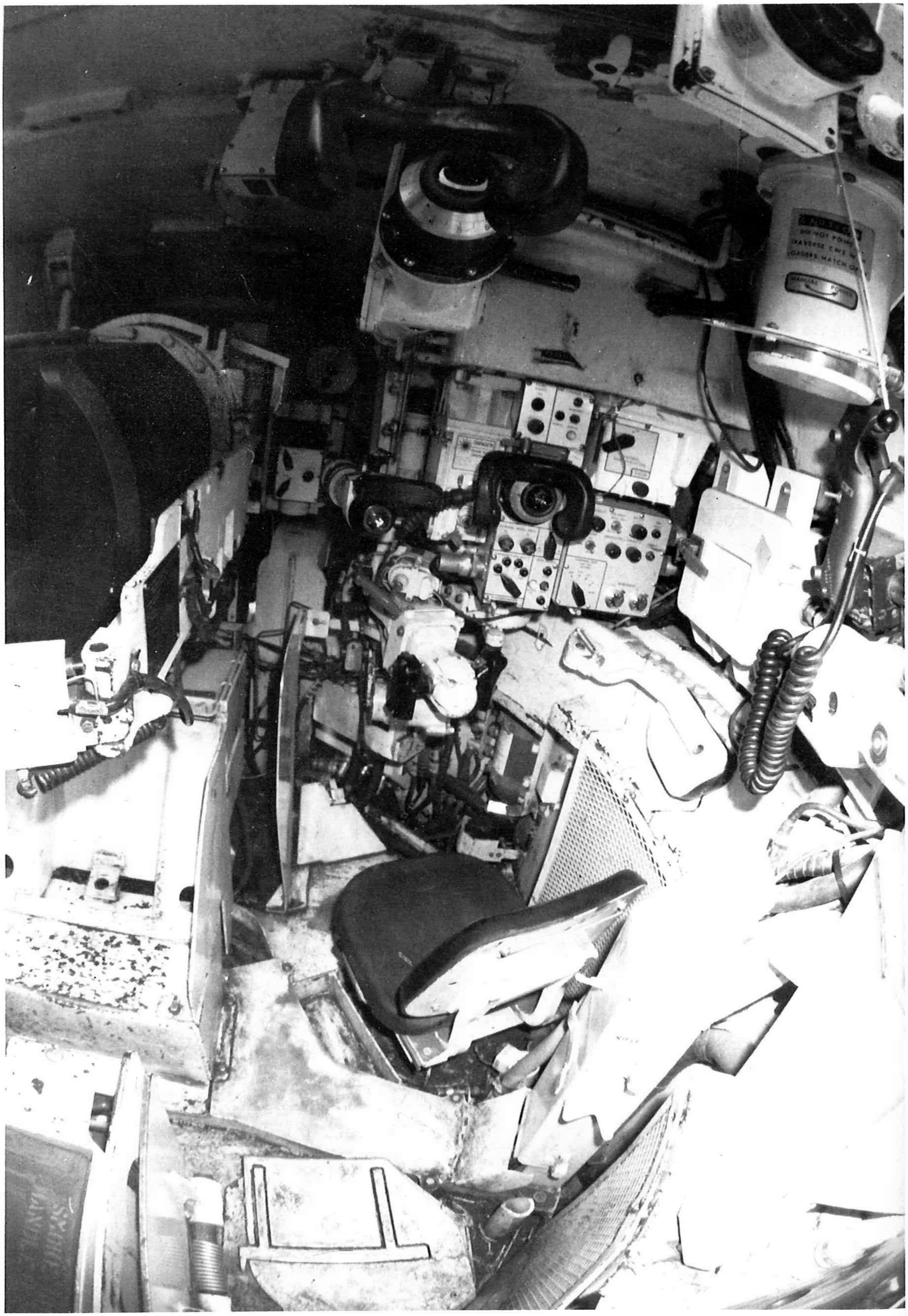
The driver's station in the M1 is quite unusual. The driver is almost prone on his back; and in place of the usual steering wheel, the driving control is more akin to a shrunken motorcycle handle bar, with twist controls for acceleration at the end. Driving the M1 is straightforward, though considerable care has to be taken at high speeds. Some of the M1 units have had problems with speed-demon drivers ploughing the tank into the solid earth after flying over a rise. This fails to amuse the turret crew, and has on occasion snapped off the front wheels! The driver has one of the less enviable locations as well. Due to the tank's considerable speed, dust and mud are thrown up in the front, and a face protector and goggles are *de rigueur*. The driver has a passive night starlight viewer for night operations, though usually the main tank thermal sight is also used, and the commander or gunner can provide warnings of obstructions that the driver cannot see.

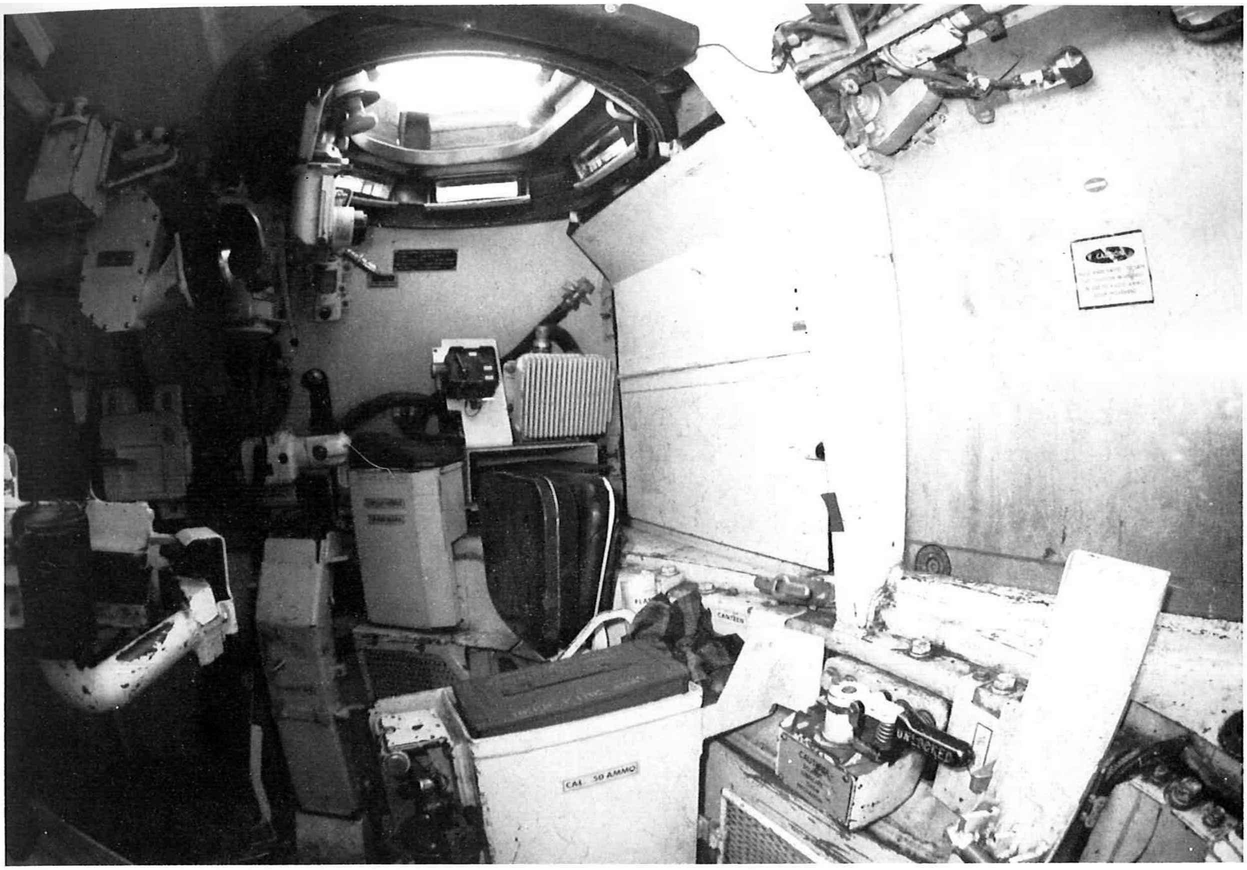


Current US tank ammunition: (1) M830 120 mm HEAT-T (2) M829 120 mm APFSDS-T (3) M483A1 105 mm HEAT-T (4) M833 105 mm APFSDS. These are all combat munitions, with black projectiles in aluminium-coloured casings; training rounds have a similar appearance, but the projectiles are finished in pale blue.

The turret layout is conventional, with several differences. The gunner is in the righthand forward portion of the turret, with the tank commander (TC) behind and slightly above. The loader is to the left of the gun breech. The M1 is noticeably smaller inside than the M60, in spite of the massive appearance of its turret from the outside. In a way, this is comforting to the crew, since all that space is taken up by the formidable American-improved version of Chobham armour. The gunner has an integrated day/night sight in front of him as well as the various fire controls. This system is very similar to that used in the M60A3(TTS), so it does not require significantly different training. The system is fully stabilised, so that once the gunner places his reticle on the target, it remains in place even if the tank takes evasive action or bounces around across uneven terrain. The fire controls use a laser range finder which feeds the target's range into a ballistic computer. The computer automatically adjusts the aim to take into account the range, the cross-wind (fed in from a wind sensor on the tank roof), ammunition type (manually tapped in) and vehicle speed and direction (automatically fed in from a gyro system). The system is surprisingly accurate, though it takes getting used to owing to the speed of the tank cross-country. The turret swings about quite a bit if the tank is being driven evasively, and the author ended up with a good many bruised ribs and banged limbs after a few firing runs at high speeds while in the loader's position. Nevertheless, the ride, even at high cross-country speeds, is much more stable than at slower speeds in the older M60A1.

A major advantage of newer NATO tanks like the M1, M60A3(TTS), Challenger and Leopard II is the thermal day/night sight. These were pioneered in the US in the 1970s, and are finally getting into service in large numbers. They are hideously expensive, accounting for about ten per cent of the total cost of the tank, but they offer some intriguing advantages over Soviet tanks. To begin with, they are more effective at night than the older passive image intensification sights. The passive sights required a certain amount of starlight or moonlight: on a cloudy night, they were not very effective. They were also subject to 'blooming' when bright light sources such as flares, or the tank's own gun flash, temporarily blinded the delicate sight at a critical moment. In contrast, the thermal sight relies on natural infrared radiation given off by all


DO NOT POW
TRAVERSE CWS W
LOADERS HATCH OP
MANUAL
POWER

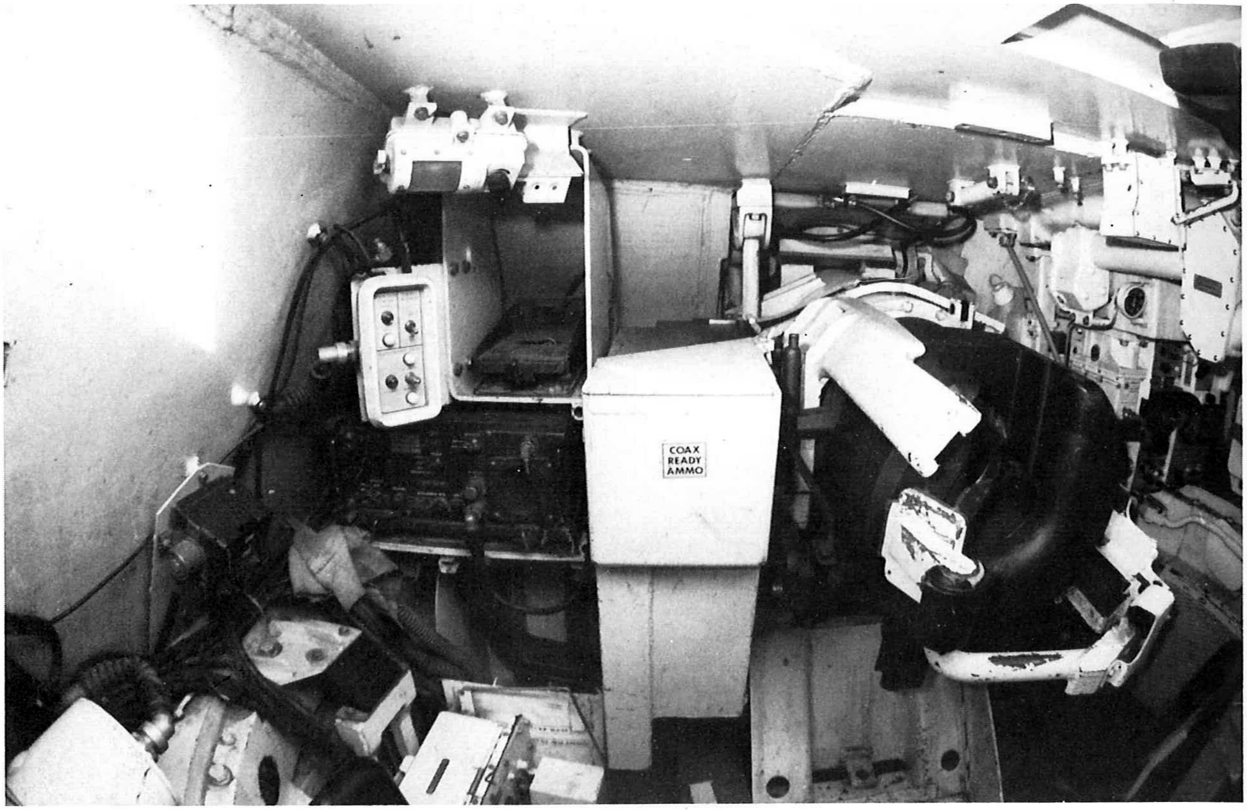


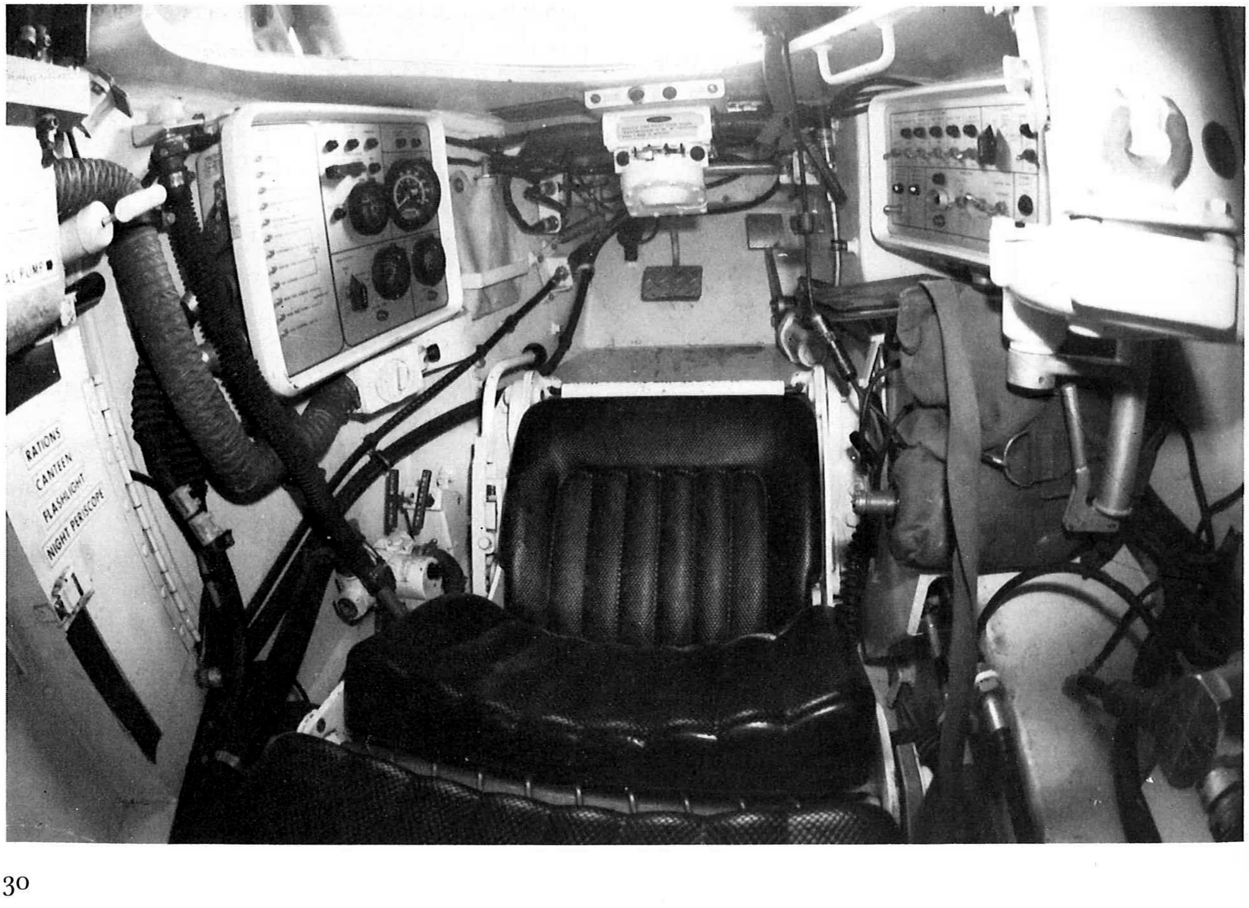
A view from the loader's station over to the commander's station. This photo clearly shows the two large blast doors which prevent ammunition fires from exploding into the crew compartment. (S. Zaloga)

objects, and creates an image by sensing the temperature differential between troops, man-made objects, etc. from the less radiant natural backgrounds. These sights are very effective in picking up tanks, due to their thermal emissions, but are also sensitive enough to detect troops. Not only are they useful at night; they can also aid daytime tactics, since they can see through haze, fog or smoke. This has an obvious tactical advantage. A tank equipped with a thermal sight can shield itself by discharging its smoke mortars, yet still 'see' hostile tanks not fitted with thermal sights. Soviet tanks have not to date appeared with these sights, and it is not clear that the Soviet Army will adopt them, due to their high cost.

The 'business office' of the commander and gunner in an M1. This photo was taken from the commander's seat, and the gunner's seat is in the centre of the picture. The gunner's controls consist of the two black handles, which can be twisted clockwise or counterclockwise to swing the turret, or forward and back to elevate and depress the gun. They are remarkably simple to use compared to the system in older tanks. For further details of the myriad components in this area, see Plate H and page 25. (S. Zaloga)

The commander has 360° vision in the low cupola, and has an optical 'elbow' which provides the same view as the gunner has through the day/night sight. The TC also has a full set of turret controls which enables him to swing the turret to a target, knowing that the gunner is seeing the same view. The commander also has a .50cal. M2 Browning heavy machine gun on a special mount which can be fired remotely from inside the tank. The tank commanders interviewed by the author had mixed feelings about this configuration, preferring a simple pintle mount instead. However, had they actually been under fire the remote control feature, though awkward, may have been more highly appreciated. In any event, the new TC cupola is definitely preferred to the M60 cupola. The cupola hatch follows the Israeli Urdan design; it can be popped open in the normal fashion, or


COAX
READY
AMMO


AL PUMP
RATIONS
CANTEEN
FLASHLIGHT
NIGHT PERISCOPE

A view of the loader's station looking forward from his seat. This area contains the vehicular radios, co-axial machine gun ready ammunition, and other stowage. The breech of the M68A1 gun is very evident in this view. (S. Zaloga)

partially opened with the thick hatch armour directly over the commander's head. This allows the commander to view the surrounding terrain without the inevitable distortion of periscopes, while at the same time protecting him from overhead artillery bursts.

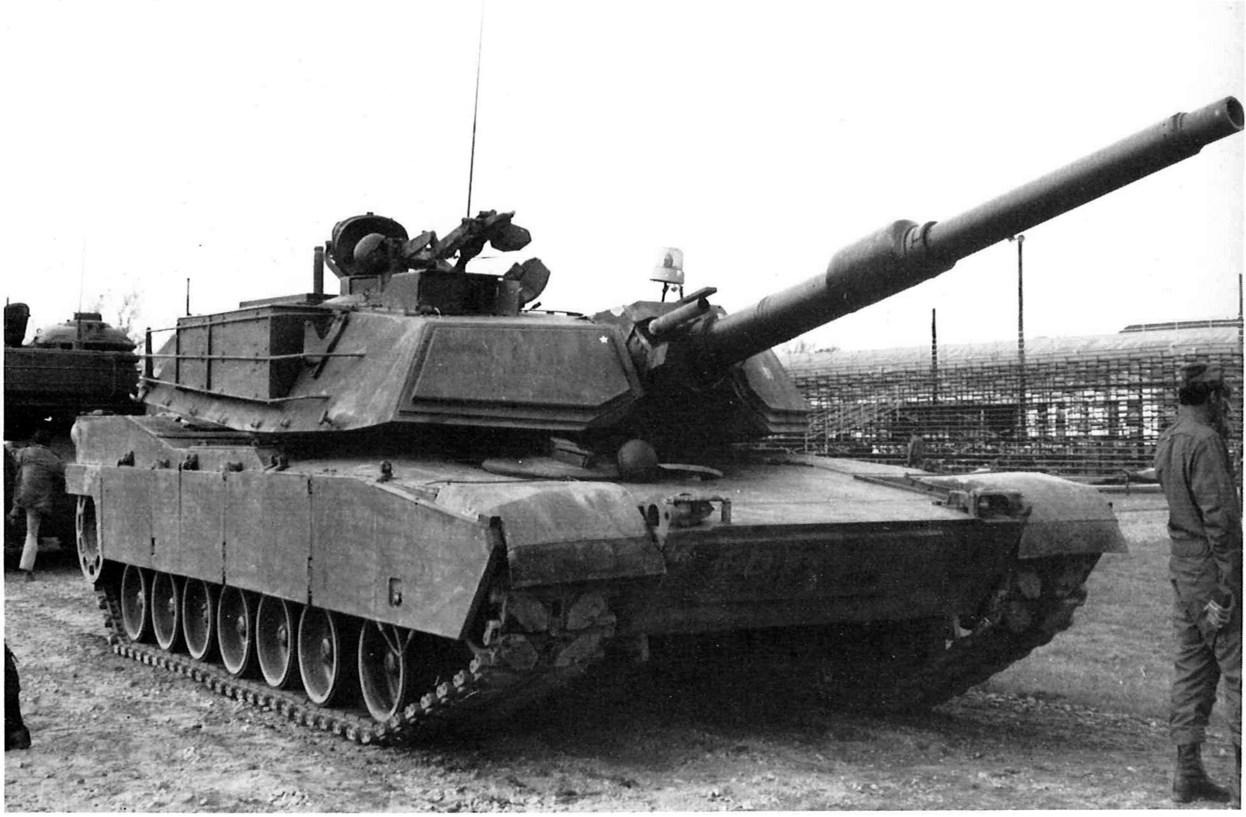
The loader's station on the M1 is well thought-out. The loader is provided with a seat due to the risks involved in standing while moving across country at high speeds. The majority of the ammunition is stowed behind protective blast doors. Should the ammunition compartment be penetrated and the ammunition ignited, the blast would be directed through roof panels instead of into the crew compartment. The doors are actuated by the loader's knee, to keep his hands free. These features are not intended to coddle the crewmen, but instead show recognition that poor tank 'habitability' degrades the rate of fire of the main gun.

A tank commander and gunner in their battle stations. The TC is viewing through his main sight, which gives him an identical view to that seen by the gunner. (S. Zaloga)

The gun in the M1 is the M68A1, a derivative of the British L7 105 mm gun. As mentioned earlier, this gun was selected due to improvements in 105 mm ammunition. The US currently prefers this smaller calibre gun because it is felt that the current ammunition can kill any Soviet tank frontally at any normal battle range. Adoption of larger calibre guns will decrease ammunition stowage. The M1 now carries 55 rounds. The latest anti-tank round is the M833 depleted uranium APFSDS, which will gradually supplant the earlier M735, M735A1 and M774 APFSDS rounds. The Israeli tank battalions credited with knocking out T-72s in Lebanon in 1982 used a round comparable in performance to the M735A1. American sources would not precisely define how much better the M774 or M833 perform; but in response to a quoted Israeli claim that the type of Israeli ammunition used in Lebanon was better than the new American types, one Army officer just chuckled. The M68A1 will be modernised in the next few years with the new M24 tube of 60-calibre length, the longer barrel offering better long-range performance. A new APFSDS round is also in the works: the XM900, which uses a refined DU penetrator.

The M1 driver lies in an almost prone position surrounded by his controls. The main controls are in the upper centre of the picture, and resemble motorcycle handlebar controls in their operation. This unit swings down so that the driver can rest it on his chest for ease of operation. (S. Zaloga)

The AGT-1500 engine has been one of the most controversial features of the M1 design. The turbine was selected due to its smaller size and lighter weight. In the light of past experience with helicopter turbines, the Army expects the turbine to have dramatically lower operations and maintenance costs. The designers acknowledged at the outset that turbines consume more fuel on average than diesels, but felt that in the long term the additional fuel costs would be outweighed by maintenance savings. An M1 consumes about 3.5 gallons in hard, cross-country travel as compared to



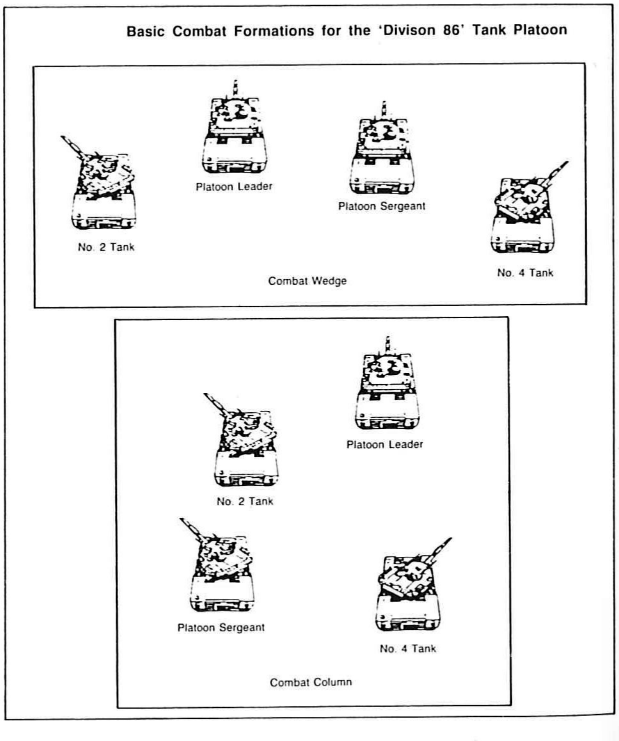
The follow-on to the M1 will be the M1E1 with the German developed M256 120 mm gun. This prototype has added armour welded to the turret and hull front to simulate the heavier armour this version will carry. When production begins in 1985, these panels will not be visible. (S. Zaloga)

about 2.4 gallons for the less powerful M60A1. In road travel, the M1 consumes about 1.8 gallons versus 1.4 for the M60A1. The results from 'Reforger' and other manoeuvres have tended to confirm that the M1 engine requires less maintenance than the M60A1, but cost advantages over the long term have yet to be proved. The M1 remains the world's only gas turbine powered tank.

The M1 Battalion

The M1 has begun to enter service at the same time as the US Army is changing the organisation of its tank battalions. The new Div-86 M1 tank battalion has 58 tanks, as compared to 54 M60s in the old battalion. The new battalion has four companies with three platoons, compared to three companies with three platoons in the old battalion. However,

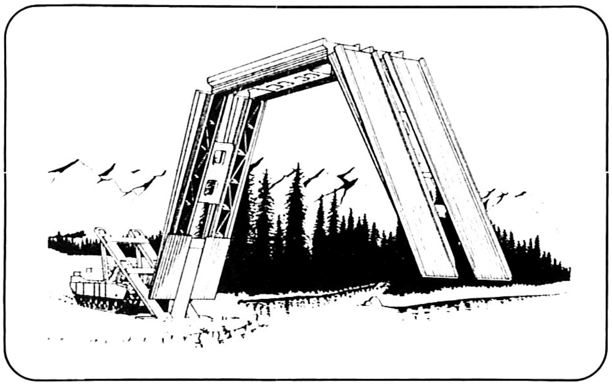
M1 Tactical Formations


Basic Combat Formations for the 'Divison 86' Tank Platoon
Platoon Leader
Platoon Sergeant
No. 2 Tank
No. 4 Tank
Combat Wedge
Platoon Leader
No. 2 Tank
Platoon Sergeant
No. 4 Tank
Combat Column

the new battalion has smaller platoons of four tanks each, compared to five in the old organisation. The battalion has also been beefed up by the addition of an M3 Bradley scout platoon. The new platoon configuration was adopted due to changes in tactics which stress the use of pairs of tanks to support each other. Two tanks individually support each other, and in a platoon, the two pairs support one another. For example, in an attacking wedge formation, one tank follows its partner and provides cover. In forward attacks, a pair of tanks move forward while the other pair remain in hull defilade to provide covering fire if the advancing pair is fired upon. In many respects the tactics resemble traditional fighter aircraft 'finger four' tactics. The current plans also call for all M1 divisions to be equipped with the new M2 Bradley infantry fighting vehicle, while divisions retaining the older M60A3 tanks will have M113 APCs in their mechanised infantry units.

Future Developments

One of the more unusual aspects of the M1 programme was that improved variants of the basic tank were being developed from the outset. The most obvious example of this is the M1E1, with the new German 120 mm gun. As an outcome of the US–FRG agreement to press forward on increased tank subcomponent standardisation, the US decided in 1976 to adopt the Rheinmetall 120 mm gun as used in the Leopard II. The US version, which has been simplified somewhat to cut down manufacturing costs, is designated the M256. The decision to adopt this gun was not without its critics within the Army. There were two causes of concern. On the one hand, the adoption of the new gun inevitably raised the cost of the M1E1 tank over the M1, and reduced the number of rounds that could be carried. Secondly, there was some concern that the German ammunition was not mature enough, and that the consuming case might cause problems. The Germans did in fact have problems with the gun and ammunition when initially deployed in the Leopard II. The casing did not always fully self-consume, and left some hot traces in the breech – which is obviously fairly undesirable! However, the solution proved quite simple. The German tankers were in the habit of swabbing out the breech after every firing with an oily rag. While this was commendable when aluminium-case ammunition was being used, it would appear that the oily residue left behind tended to bind with the new 120 mm self-consuming casing, causing the problems. Would that all the Leopard II's and M1's problems were so simple!



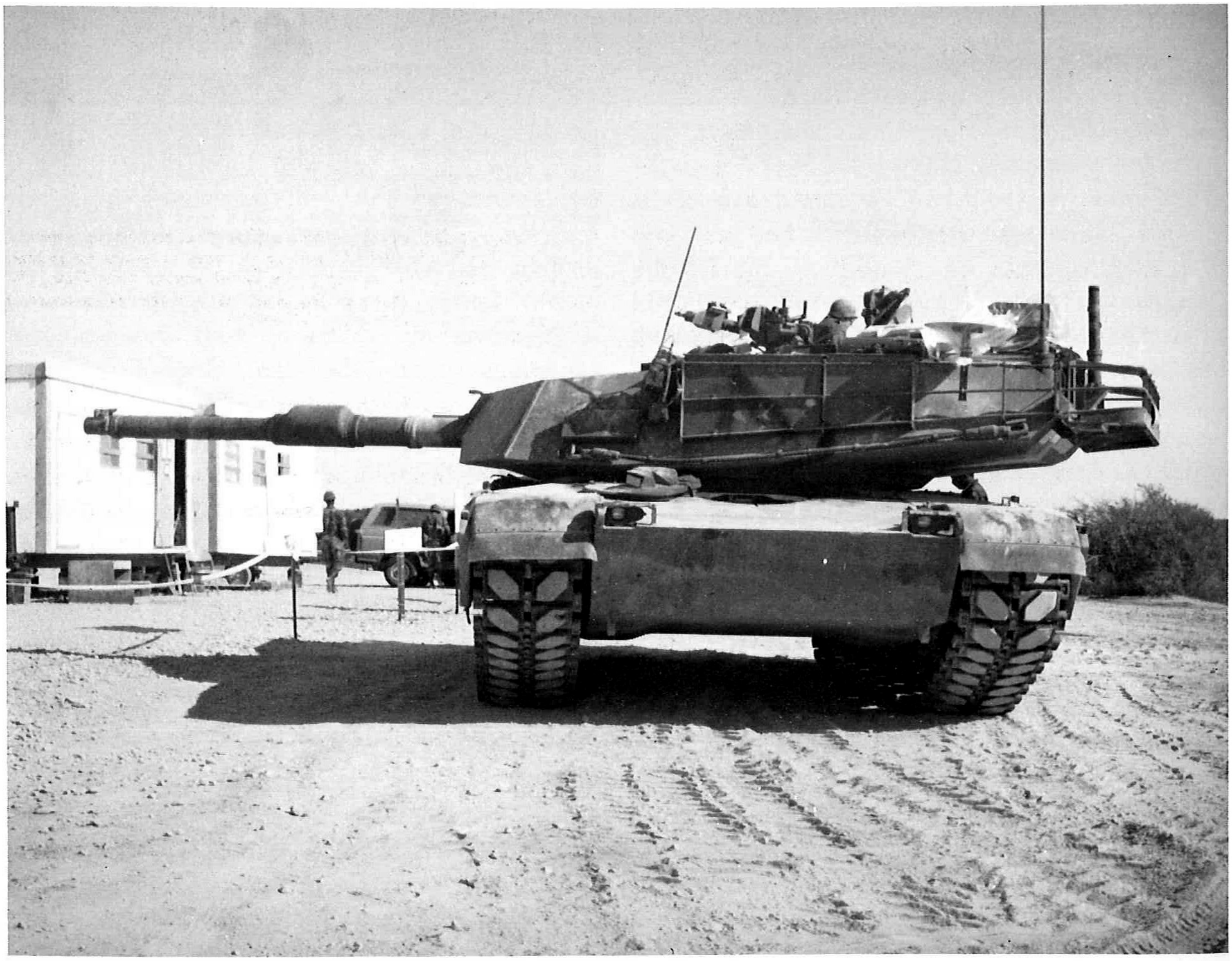
M1 Heavy Assault Bridge (HAB)

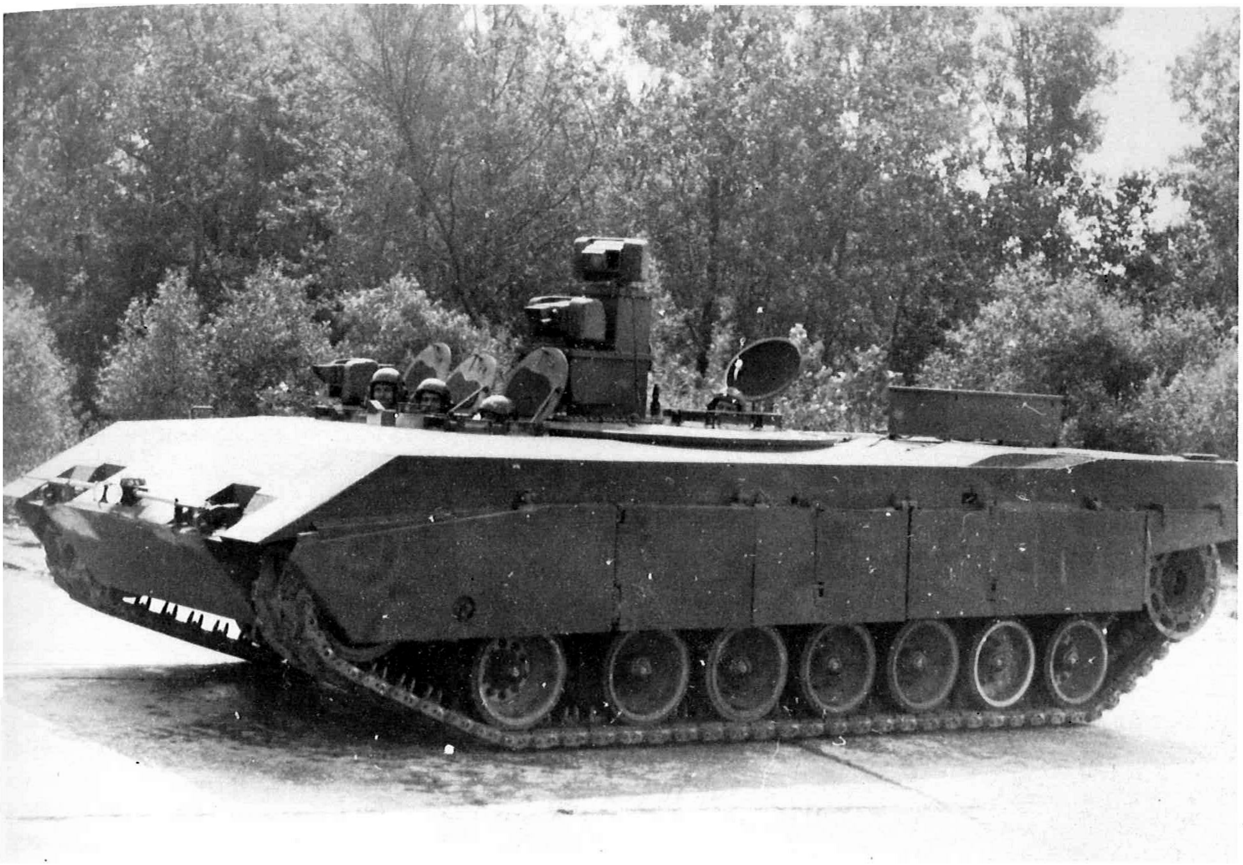
Current plans call for the production of 3,186 M1 tanks, and 3,862 M1E1 tanks; the M1E1 will probably be designated M1A1 when it reaches production in 1985. Besides the adoption of the new gun, the M1E1 will also incorporate Block 1 improvements. Two of the more important components of this effort are new thicker frontal armour, and a hybrid chemical warfare protection system. The hybrid protection unit will be based on an overpressure system to keep chemical contaminants outside the tank. One of the more unusual aspects of the system is that it will provide special cooling vests for the crew. The main problem with most chemical suits is that they inevitably cause heat exhaustion in the wearer in a very short time even in temperate climates. The cooling vest will allow the crew to wear the chemical protection suit without the normal debilitating effects.

For the long term, the Army is developing two more block improvement programmes, and examining a possible turret reconfiguration. Block 2, which would be adopted by tanks produced after 1988, may include a new tank commander's station with a separate thermal sight, a driver's thermal sight, a land navigation system, an improved laser rangefinder, a fast refuel system, and a new smoke discharger system which will be capable of obscuring the tank from thermal sights. Block 3 may include an engine infrared suppression system, additional overhead armour, and a new evasive target fire control system based around the experimental Startle millimetre wave radar. The new fire control system would track the projectile on the way to its target and simultaneously track the target in order to adjust the fire of later rounds. A more sensitive area of development is ammunition improvement. The US Army has confirmed that it is developing a guided 105 mm tank projectile, but details are classified. It is also developing a ram-jet-powered 105 mm round with the aim of increasing even further the accuracy and penetration power of depleted uranium kinetic energy penetrators.

As a long-term effort, the XM1E2 Tank Test Bed (TTB) is also in the works. Two TTB prototypes are being developed with new low-profile turrets designed by Rheinmetall and FMC. This programme is examining whether low-profile turrets, akin to that used on the old M60A2 tank, might not increase tank survivability. Another derivative of the M1 is the Surrogate Research Vehicle (SRV). This is a turretless test vehicle which is examining potential fire control systems, crew configurations and other conceptual ideas. Two more mundane programmes are the HAB and countermine projects. The HAB (Heavy Assault Bridge) is a bridging tank version of the M1 to replace the M60AVLB in M1 units. The integrated countermine project is involved in developing mine rollers and other combat engineer devices for the M1, such as a 'dozer blade for entrenching.

An M1E1 during operational trials at Ft. Hood in 1983. This view shows the basket assembly that has been added on the turret rear for additional stowage. The M1E1 also incorporates many internal improvements. (Ft. Hood Public Affairs)





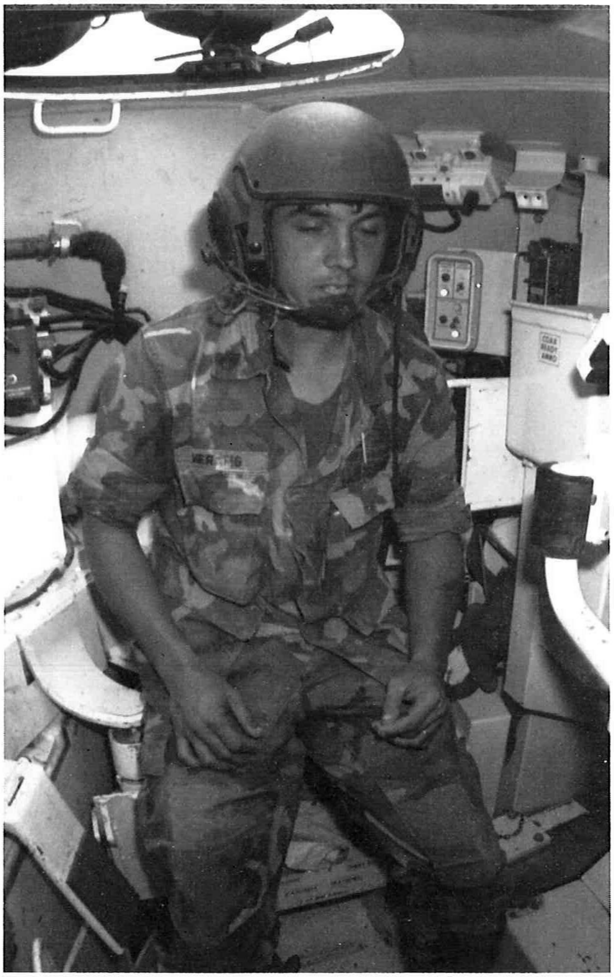
The Surrogate Research Vehicle (SRV) is an experimental version of the M1 designed to test new tank sensors and other advanced technology concepts. As is evident in this view, the vehicle has a three-man crew, with the driver, commander and gunner all in the hull. (TACOM)

While many feel that the M1 and its contemporaries such as the Leopard II and Challenger represent the last generation of heavy main battle tanks, the jury is still out. Armour and ammunition improvements continue to ensure the viability of main battle tanks on the modern battlefield, and continue to enhance their firepower and defensive strengths. Many of the new technological wonders that were supposed to doom the tank, such as precision guided munitions, have yet to prove themselves. Furthermore, even if the technical 'bugs' in such weapons are overcome, tank countermeasures are likely. For example, laser-guided projectiles like the US M712 Copperhead 155 mm round require active laser designation. There already exist simple detectors that can be fitted to tanks to trigger laser-jamming smoke dispensers when a coded laser beam is directed at a tank. Precision guided munitions using millimetre wave guidance can conceivably be jammed; and heat-seeking PGMs have proved to be very difficult to develop. Probably the main new threat to tanks will not be these high cost munitions, but rather the simple and inexpensive new air-scatterable mines that can be sewn using artillery or rocket projectiles. Unlike hand-laid minefields, these could be dropped right into the midst of a moving tank formation, severely restricting the mobility of the tanks. Track remains the Achilles heel of the tank, as it has since the first days of tank warfare in World War I.

The Plates

A1: M1 Abrams, Initial Production Vehicle L1

The initial series production vehicle from the Lima, OH Tank Plant was christened 'Thunderbolt' in memory of the M4 Sherman tank that Creighton



US Army tank crewman wearing standard 'woodland' camouflage 'BDUs' and CVC helmet. (S. Zaloga)

Abrams commanded in 1944 in France. (The insignia painted on the vehicle actually differs in detail from the insignia on Abrams' tank: see Plate B1 in Vanguard 26, *The Sherman Tank in US and Allied Service*.) This M1, like all production vehicles fresh from the factory, is finished in monotone Forest Green.

A2: M1 Abrams, 1/66 Armor, 2nd Armored Division; Ft. Hood, Texas, 1983

This M1 Abrams of 1/66 Armor is painted in one of the more common variations of the four-tone MERDC scheme, consisting of Forest Green and Field Drab as the primary colours and Sand and Black as the secondary colours. This scheme is officially termed 'US & Europe Winter Verdant', but is widely used in other circumstances. However, the scheme on this vehicle is not identical to the official pattern. The markings consist of the usual style of bumper codes, which identify the division, regiment and battalion on the left and the company and vehicle (B-31) on the right. The numbers are painted on a block of sand-colour so that they are easier to read. The other unit markings include the charging knight insignia on the turret that was used as a battalion insignia in 1982–83. The name BEASTMASTER is a further indication that the tank belongs to B Company. Although not evident in this view, the tank also carried the black triangle marking of the 2nd Armd. Div. as shown on Plate D1.

B & C: MERDC camouflage patterns

These eight side views show the full range of schemes in the MERDC four-colour camouflage system. The system was developed by the US Army Mobility Equipment R&D Command (MERDC) at Ft. Belvoir in the early 1970s. The schemes employ up to 12 colours: FS30118 Field Drab (FD), FS34079 Forest Green (FG), FS30277 Sand (S), FS37038 Black (BLK), FS34102 Dark Green (DK), FS34151 Light Green (LG), FS30257 Earth Yellow (EY), FS30279 Desert Sand (DS), FS34087 Olive Drab (OD), Earth Brown, Earth Red and White. These are nearly identical to the standard US Engineer colours in use since World War II, though the new paint has infrared suppression qualities. These shades are used in the eight basic patterns as primary and secondary colours. The primary colours, shown here in the first two columns, cover about 45 per cent of the surface each. The two secondary colours cover about 5 per cent each:

Plate number/Pattern	*Colours*			
	(Primary)		*(Secondary)*	
B1: Winter, US & Europe Verdant	FG	FD	S	BLK
B2: Snow, temperate with trees and shrubs	FG	W	S	BLK
B3: Snow, temperate with open terrain	W	FD	S	BLK
B4: Summer, US & Europe Verdant	FG	LG	S	BLK
C1: Tropics, Verdant	FG	DG	LG	BLK
C2: Red desert	ER	EY	S	BLK
C3: Gray desert	S	FD	EY	BLK
C4: Winter Arctic	W	W	W	W

A major aim of this system was to permit the easy alteration of the scheme for different seasons or regions by simply repainting a single one of the colours. The main drawback to the system was that the patterns were often not followed with any degree of precision.

In 1984 the US Army, under pressure from its NATO allies (particularly Germany), agreed to begin adopting a common NATO colour scheme developed by Germany. The Bundeswehr fears that the current practice of each army having its own camouflage patterns simplifies Warsaw Pact intelligence since the nationality of any vehicle can be identified simply by its scheme. The new scheme is simpler in appearance and consists of a pattern of Forest Green, Black and Field Drab. As of the time of writing the Army had not completed design of the final M1 scheme, which is not expected to be approved until the end of 1984. In contrast to the earlier scheme, the new scheme will be applied at the factory rather than in the field in order to ensure uniformity.

D1: M1 Abrams, 3/67 Armor, 2nd Armored Division; Ft. Hood, Texas, 1983

This M1 of D Co., DESTRUCTOR shows the most common paint scheme of the M1, overall Forest Green. Many US-based and most European-based M1 battalions have been left in this monotone scheme. The markings on this vehicle include a triangular insignia on the turret which is used to distinguish tanks of the 2nd Armd. Div. from those of the 1st Cav. Div., as both are stationed at Ft. Hood. The skirt markings consist of a company insignia (a square for D Co.) and the battalion insignia, selected after the battalion's name, 'The Hounds of Hell'. In 1984 the 2nd Armd. Div. began adopting a new system of unit markings, which is shown below.

D2: M1 Abrams, 2nd Armored Division Demonstration Team; Saudi Arabia, 1983

In 1983 a demonstration team of two M1 Abrams and two M2 Bradley Infantry Fighting Vehicles was dispatched to Saudi Arabia, which had expressed interest in buying these types. The vehicles were finished in an overall Sand scheme, and the unit added a small palm tree insignia to the turret fronts. The bumper codes carried fore and aft in usual positions were e.g. '2△17T', 'T50'. The individual vehicle numbers were also repeated on the hull sides. The tank shown here, 'T55', had two black barrel stripes, while the other tank had one.

D3: Regimental Insignia

Since 1982, US tank battalions have begun to adopt new systems of regimental and battalion insignia. There is no standardised form common to all divisions, though there are obvious similarities. In Europe, the tank battalions of the 64th Armor have adopted large yellow panels attached to the turret rear. The shape distinguishes the battalion; in the two cases shown here, a four-sided diamond (1–4) indicates 1/64 Armor, and a hexagon (5–8) indicates 2/64 Armor. In turn, the black geometric shape inside indicates the company: triangle (A Co.); square (B Co.); circle (C Co.); downward triangle (D Co.). Inside these symbols is a white bar signifying the platoon.

The 11th Armored Cavalry uses a related system. 11 ACAV uses a Forest Green circle, with markings in yellow. The outermost yellow geometric shape indicates the squadron (in this case, 1/11 ACAV); the next, the troop (in the same sequence as 64 Armor); and finally, vertical bars indicate the platoon.

In contrast to these units, the 2nd Armd. Div. adopted a system of painting similar markings on the back of the tank commander's hatch. In this case the basic geometric shape is painted in the regimental colour (66 Armor – white; 67 Armor – yellow; 252 Armor – light green). The shape of the basic coloured design indicates the battalion: 1st Bn. – diamond; 2nd Bn. – square; 3rd Bn. – circle. Therefore, insignia 13 here is from 1/66 Armor, 14 is from 1/67 Armor, etc. The black inside design indicates the company: A Co. – diamond; B Co. – square; C Co. – circle; D Co. – pentagon. As in the case of the European systems, the white vertical bars indicate the platoons, numbered 1–3. The illustrations 13–18 show the six battalions by company.

E1: M1 Abrams, 2/64 Armor, 3rd Inf. Div.; 'Reforger' Exercise, Germany, 1982

This tank is finished in the standard fashion of the M1s of the 64th Armd. Regt. during its initial manoeuvre deployment in the 'Reforger '82' exercise. As part of the Blue Army, each tank had a large blue 'national insignia' pasted or taped on to the turret front. The black '53' indicates the unit. Aside from this manoeuvre marking, this tank carries standardised insignia. The bumper codes are '31-2△64', 'C22'. This tank also carried the large rear turret plates explained under Plate D3. The red bar on the front fender is a strip of reflective tape used for safety purposes during night driving. This tank, like nearly all M1s in Europe, is finished in overall Forest Green.

E2: M1 Abrams, 2/64 Armor, 3rd Inf. Div.; 'Reforger' Exercise, Germany, 1982

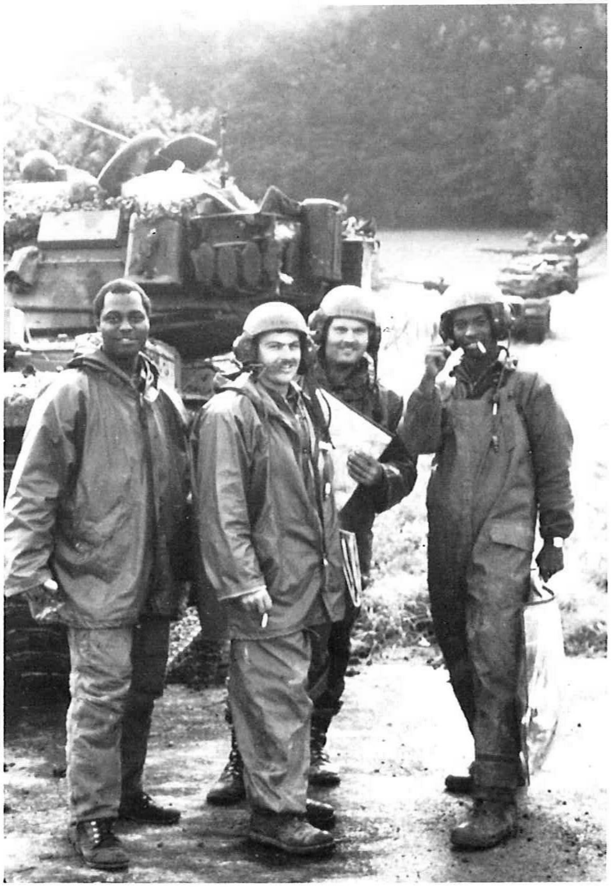
This M1 is finished identically to the other vehicle from its company shown in the Plate above. This view shows the standard rear location for the bumper codes, and the regimental insignia. Note that the company and individual vehicle/platoon code is repeated on the hull side. This vehicle's exhaust louvres have been damaged in the exercise.

F1: M1 Abrams, 1/11 ACAV; 'Reforger' Exercise, Germany, 1983

In 1983 the 11th Armd. Cav. supplied the M1 battalion taking part in 'Reforger'; curiously enough, this unit was commanded by one of Creighton Abrams' sons! Col. Abrams showed some imagination and cunning in selecting camouflage for his tanks. German units taking part in 'Reforger' are often camouflaged with bands of mud; and to confuse 'opposing' Bundeswehr units, Abrams had his unit do the same. On occasion he also had some elements of his squadron modify the unit insignia – white '74' on a Blue Army square – by muddying-over the numbers to look like another code. Bumper codes were also intentionally obscured with mud, to further confuse 'enemy' intelligence; and foliage was added for good measure.

F2: M1 Abrams, 11 ACAV; 'Reforger' Exercise, Germany, 1983

This tank of 1/11 ACAV shows the use of mud camouflage in a polka-dot pattern; and the large regimental/squadron markings used by 11 ACAV on the turret rear. (The author would like to acknowledge Arnold Meisner's research in the preparation of these two schemes.)



These tankers are wearing the standard US Army foul-weather gear including the poncho, coveralls and muckluck boots. (Arnold Meisner)

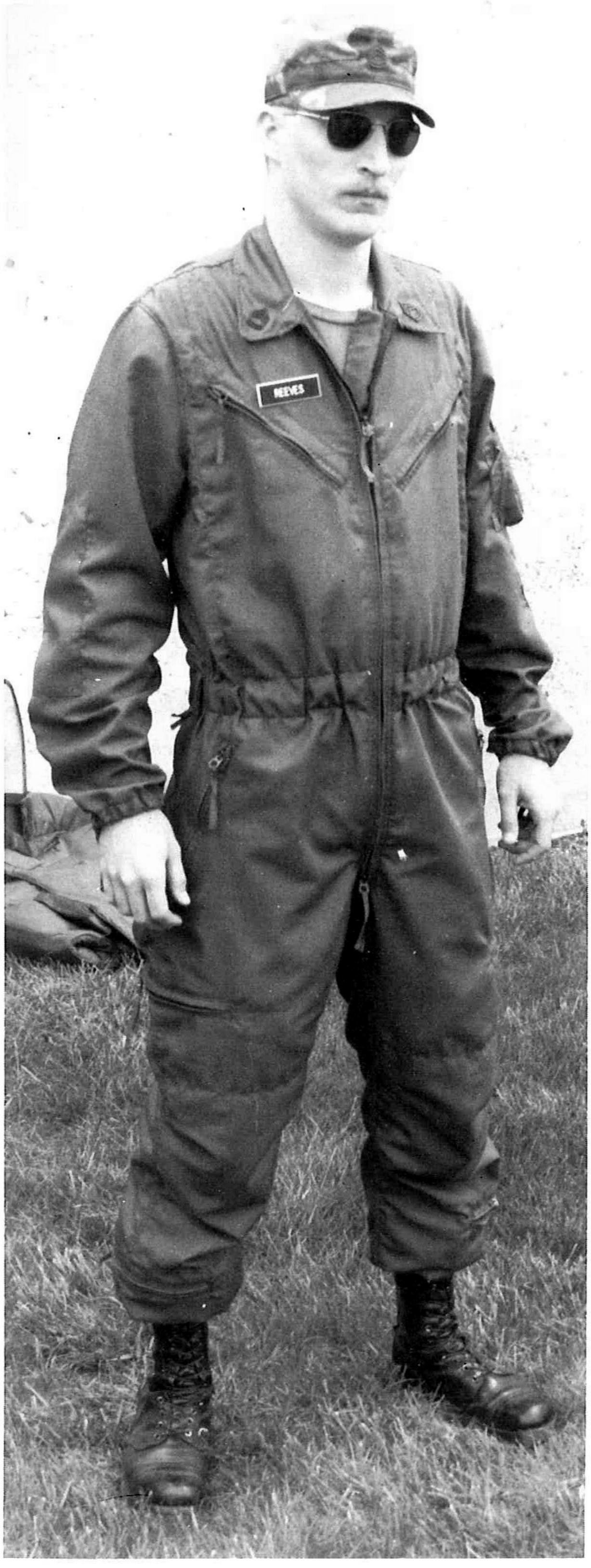
G: Abrams crew uniforms (artwork by Andy Carroll):

G1: Sergeant, US tank unit, 1984

To date the most common forms of tanker's battle-dress have been simply the standard 'BDUs' (Battle-Dress Uniform) either in OG-107 green or in the current 'woodland' camouflage. These uniforms are identical to standard infantry dress, apart from the associated use of the CVC (Combat Vehicle Crewman) helmet. This NCO models the new synthetic Nomex tanker's coveralls, in a dark shade of olive green. Note that metal ranking is worn on both the coverall collar and the 'woodland' camouflage fatigue cap. The venerable M3 'grease gun' is still the standard crew weapon.

G2: US tank crewman, Nomex Battle-Dress, 1984

This Nomex anti-blast suit is being developed by



the US Army Natick Laboratories. Designed for wartime use only, it is intended to reduce crew casualties from internal fires. The new fire suppression systems in the M1 can put out a blast in milliseconds, but the suit serves to protect crews from the initial flash. It consists of a basic coverall, a tanker's jacket rather similar to the old World War II type, a protective facial mask, goggles and the CVC helmet. The basic material is somewhat lighter in shade than normal OG-107 cotton fabric. The blast gloves are of pale green cloth with black rubberised palm and finger surfaces. These new rough-finish brown leather tanker's boots, strapped rather than laced, will probably replace the black boots worn by G1; at the time of writing their issue is held up by design problems.

G3: US tank crewman, CBR Battle-Dress, 1984
This figure is shown in the full MOPP chemical warfare suit that will be worn in the M1E1 tank. It consists of a disposable, charcoal-impregnated outer suit in 'woodland' camouflage, similar to the familiar 'BDUs', and worn over them or the usual coveralls. Under these, in turn, will be the water-cooled vest mentioned earlier. This soldier holds the tubing that leads under the jacket to the vest, and the green tube that feeds the CBR mask. He also wears the CVC helmet, protective hood and face mask. The black rubberised gloves are disposable. Since disposable boots would be too expensive, a type of laced rubberised 'bag' with tightening laces has been developed, which fits over the standard footwear. Some other typical US tankers' uniform items will be seen in accompanying photos, including the wet weather poncho.

H: M1 Abrams crew stations
H1: Gunner's station; H2, tank commander's station; H3, loader's station
Key drawing and explanatory text will be found on page 25; see also the photos and captions on pages 28 to 31.

Sgt. Reeves of Aberdeen Proving Grounds shows the new US Army tanker's coveralls. These are made of a dark green OG-107 fabric. (S. Zaloga)

Notes sur les planches en couleur

A1 Le premier véhicule sorti de la chaîne de production fut appelé '*Thunderbolt*' ('coup de tonnerre'), comme le tank Sherman du Gén. Abrams de la seconde guerre mondiale. **A2** La version '*US & Europe, Winter Verdant*' (Vert d'hiver, Etats-Unis et Europe) des dessins de camouflage réglementaires de *MERDC*. Les abréviations habituelles de l'armée américaine sur le front de la coque permettent de reconnaître l'unité. Le triangle noir de la 2e Division – voir illustration D1 – est caché dans cette vue. Le tank s'appele '*Beastmaster*' ('Maître de la Bête').

B, C Les huit variations principales des programmes de camouflage de *MERDC*. Apparemment, un programme de camouflage commun pour tous les tanks de l'OTAN est en cours de préparation, pour des raisons de sécurité, afin que l'aspect d'un tank n'indique pas automatiquement sa nationalité.

D1 '*Destructor*' ('Destructeur') présente le dessin entièrement vert, qui est le plus commun sur le modèle Abrams en Europe. L'insigne en triangle de la tourelle permet de reconnaître la division. Les insignes sur le côté sont un carré (Compagnie D) et l'insigne 'Hell-Hound' du bataillon. Les insignes présentées comme D3 sont plus tardives que celles-ci. **D2** Tank appartenant à une équipe de démonstration envoyée en Arabie Séoudite, camouflage de couleur sable, avec un petit insigne de palmier. **D3** Système de repérage existant depuis 1982: (1–4) Les compagnies du *1st Bn., 64th Armored Regt.*; (5–8) *2nd. Bn. 64th Armor*; (9–12) *1st Bn., 11th Armored Cavalry*; (13) Les compagnies du *1st Bn., 66th Armor*; (14) *1/67 Armor*; (15) *2/66 Armor*; (16) *2/252 Armor*; (17) *3/66 Armor*; (18) *3/67 Armor*.

E1 Les insignes sont l'identification abrégée habituelle sur l'avant de la coque; l'insigne présentée à D3 pour cette unité et l'insigne '53 sur bleu' portée par cette unité faisant partie de 'l'armée bleue' pour ces manoeuvres. **E2** Tank identique, montrant l'emplacement des insignes arrière.

F1 Cette unité – commandée par un fils du Gén. Abrams – a ajouté de façon ingénieuse un camouflage de boue pour cet exercice, copiant la pratique des unités de tank Leopards de la *Bundeswehr*. **F2** Un autre style de camouflage de boue utilisé par la *11th Armored Cavalry* durant '*Reforger '83*'.

G1 La nouvelle salopette vert foncé en tissu nomex des equipes des tanks américains. **G2** Le masque de visage, l'anorak rappelant celui de la seconde guerre mondiale et les bottes à courroies sont des caractéristiques notables de ce nouveau uniforme ignifugé destiné aux équipages des Abrams. **G3** Costume de protection contre la guerre chimique *MOPP* complet; la couche extérieure camouflée est une salopette à jeter, imprégnée de charbon de bois, portée avec un masque *CBR*, une capuche protectrice et un gilet refroidi par eau permettant un port prolongé.

H Positions du canonier, du commandant et du chargeur dans l'Abrams M1; un dessin-clé et la liste des articles (en anglais) se trouvent à la page 25.

Farbtafeln

A1 Das allererste Fahrzeug dieser Art wurde nach dem Sherman-Panzer vo General Abrams im 2. Weltkrieg '*Thunderbolt*' genannt. **A2** Die '*US & Europ Winter Verdant*' – Ausführung der regulären *MERDC*-Tarnung. Die für die US Armee üblichen Abkürzungen vorn auf dem Rumpf geben die Einheit an. Di Markierung der 2. Division in Form eines schwarzen Dreiecks, die Sie in de Beschreibung D1 sehen, ist hier verdeckt. Der Panzer hat den Name '*Beastmaster*'.

B, C Hier sehen Sie die 8 verschiedenen Ausführungen der *MERDC*-Tarnung Angeblich führt man derzeitig aus Sicherheitsgründen ein allgemeine Tarnschema für alle NATO-Panzer ein, damit die Nationalität nicht sofort zu erkennen ist.

D1 Die meisten Abrams in Europa sind wie dieser Panzer '*Destructor*' durchweg grün gestrichen. Die dreieckige Geschützmarkierung gibt die Division an. Di Seitenmarkierungen bestehen aus einem Viereck (D-Kompanie) und den 'Hell-Hound'-Insignien des Bataillons. Die Markierungen in D3 sind neueren Datums **D2** Der Panzer eines Vorführteams für Saudi-Arabien. Er ist als Tarnung sandfarben gestrichen und mit kleinen Palmeninsignien versehen. **D3** Da Markierungs-system seit 1982: (1–4) Kompanien des *1st Bn., 64th Armored Regt.* (5–8) *2nd Bn., 64th Armor*; (9–12) *1st Bn., 11th Armored Cavalry*; (13) Kompanien de *1st Bn., 66th Armor*; (14) *1/67 Armor*; (15) *2/66 Armor*; (16) *2/252 Armor*; (17) *3/6 Armor*; (18) *3/67 Armor*.

E1 Vorn auf dem Rumpf sehen Sie die üblichen abgekürzten Kennzeichen. Diese Einheit hat diesselbe Markierung wie D3, und die Insignien, '53-on-blue', bedeuten, dass die Einheit in diesem Manöver zur 'Blauen Armee' gehört. **E2** Derselbe Panzer mit den Insignien hinten.

F1 Diese Einheit unter General Abrams Sohn hat ihre Panzer für diese Übung mit Schlamm getarnt, eine Tarnung, die sie von den Leopard-Einheiten der *Bundeswehr* kopiert hat. **F2** Eine andere Art Schlammtarnung der *11th Armored Cavalry* während dem '*Reforger '83*'-Manöver.

G1 Der neue, dunkelgrüne Overall fur Amerikanische Panzerbesatzungen in Nomex. **G2** Die Gesichtsmaske, die Windjacke, die an den 2. Weltkrieg erinnert, und die Riemenstiefel sind auffällige Merkmale der neuen, feuerfesten Uniform für Abrams-Besatzungen. **G3** Vollständige *MOPP*-Schutzausrüstung gegen chemische Waffen; die getarnte Aussenschicht besteht aus einem mit Holzkohle imprägnierten Wegwerf-Overall, den man mit *CBR*-Maske, Schutzkappe und wassergekühlter Weste trägt.

H Die Positionen des Schützen, des Kommandanten und des Ladeschützen im M1-Abrams; eine Zeichnung sowie Zubehörteile finden Sie in englischer Sprache auf Seite 25.

OSPREY · VANGUARD

A series of books describing key units and weapons systems of 20th century warfare, prepared by leading military experts for the enthusiast and modeller, and illustrating authentic details of armour and supporting vehicles, camouflage, markings, uniforms, insignia and weapons.

Avec annotations en francais sur les planches en couleur

Mit Aufzeichnungen auf deutsch uber die Farbtafeln

(3) US 1st Infantry Division 1939–45
(6) The Lee/Grant Tanks in British Service
(8) US 1st Marine Division 1941–45
(13) The Churchill Tank
(15) The Sherman Tank in British Service 1942–45
(16) The Panzerkampfwagen III
(17) The Stuart Light Tank Series
(18) The Panzerkampfwagen IV
(19) Armour of the Middle East Wars 1948–78
(20) The Tiger Tanks
(21) The PzKpfw V Panther
(22) The Centurion Tank in Battle
(23) British Tanks in N. Africa 1940–42
(24) Soviet Heavy Tanks
(25) German Armoured Cars and Recce Half-Tracks 1939–45
(26) The Sherman Tank in US and Allied Service
(27) Armour of the Korean War 1950–53
(28) The 6th Panzer Division 1937–45
(29) The M47 & M48 Patton Tanks
(30) Polish Armour 1939–45
(31) US Half-Tracks of World War II
(32) The SdKfz 251 Half-Track
(33) German Light Panzers 1932–42
(34) M113 Series
(35) Armour of the Pacific War
(36) Long Range Desert Group
(37) Modern Soviet Combat Tanks
(38) Mechanised Infantry
(39) US Armour Camouflage and Markings 1917–45
(40) US Light Tanks 1944–84: M24 Chaffee, M41 Walker Bulldog and M551 Sheridan
(41) The M1 Abrams Battle Tank
(42) Armour of the Vietnam Wars

STEVEN J. ZALOGA was born in 1952, received his BA in history from Union College, and his MA from Columbia University. He has published over twenty books and numerous articles dealing with modern military technology, especially armoured vehicle development. His main area of interest is military affairs in the Soviet Union and Eastern Europe in the Second World War, and he has written as well on American armoured forces. Steven Zaloga lives in Connecticut.

ISBN 0 85045 584 7